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B. G. SCHUBERT
EDITOR

L. I. NEVLING, JR. C. E. WOOD, JR.

LAZELLA SCHWARTEN
CIRCULATION

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VOL. 46 JANUARY 1965 NUMBER 1

LETTERS FROM CHARLES SPRAGUE SARGENT TO REGINALD SOMERS COCKS, 1908–1926 *

Edited by JOSEPH EWAN [1]

WHEN CHARLES SPRAGUE SARGENT DIED IN 1927, after serving 54 years as Director of the Arnold Arboretum, he left a varied and significant legacy of botanical accomplishment. The Arnold Arboretum which he established is a monument to his vision, energy, and ability. His published works are a record of his interest in and knowledge of woody plants. After completion of his *magnum opus*, the *Silva of North America* (1891–1900), Sargent wrote the *Manual of the Trees of North America* which was, in fact, a condensed version of the *Silva*, available to many more interested people than had access to the original work of 14 folio volumes.

The production of a manual with its necessarily concise statements of characterization, distribution, uses, and so forth, entails an enormous effort and a refinement of style not easy to achieve. To obtain the greatest pos-

* In response to a request by the editors of the Journal of the Arnold Arboretum, Professor Joseph Ewan, whose contributions to the history of American botany are well known, has prepared for publication this series of letters from Professor Sargent to Professor Cocks. It is felt that such an extensive paper, to be published in parts in the four numbers of Volume 46, will provide valuable background to the botanical history of a floristically critical area, the southeastern United States, now being studied intensively. *Eds.*

[1] The 302 letters of Charles Sprague Sargent reproduced here have been faithfully transcribed from the originals preserved at Tulane University. They were typewritten by Sargent's secretary who usually did not verify the spelling of place names. The misspelled place names and a few obvious errors in botanical names have been corrected. All the letters carried the heading "Jamaica Plain, Mass.," although it is possible some were written away from the Arboretum during Sargent's excursions. Salutations are uniform, and since they follow the form of the first letter, have not been repeated thereafter. The valediction, "Faithfully yours," which was used consistently has also been omitted. Generic names were not italicized (which must have saved hours in the aggregate!) but have been italicized here. The letters are separated by Arabic numbers and are referred to by number (not by page) in the INDEX TO PERSONAL NAMES and the INDEX TO PLANT NAMES.

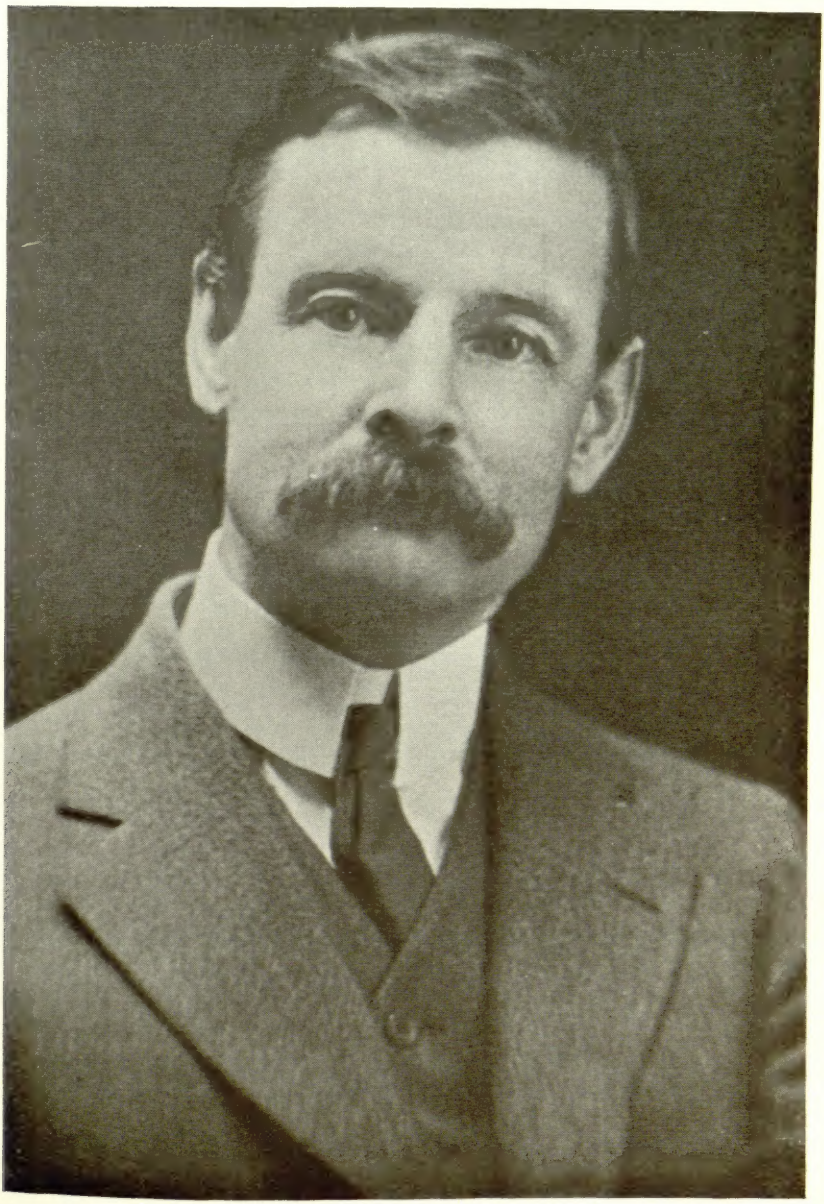
The only published Sargent letters of which I am aware are those selected and annotated by BERNARD HARKNESS of Highland Park Herbarium, Rochester, New York, and published as "Excerpts: letters of Charles Sprague Sargent to Rochester Park Personnel" (Rochester Chapbooks, Publisher, 1961, 51 pp.), chiefly to Mr. JOHN DUNBAR (1859–1927), with footnotes identifying most of the persons mentioned.

sible precision in statements of range and other details, Sargent encouraged correspondents in various parts of the country to provide specimens and all available information about the trees in their particular localities. From the time of publication of the first edition of the *Manual* Sargent worked for approximately fifteen years toward the completion of the second edition. Among the many correspondents who contributed to the effort, Sargent especially mentioned, in the preface to the second edition, Alice Eastwood who collected in Alaska and New Mexico, and Professor Cocks who explored the forests of Louisiana.

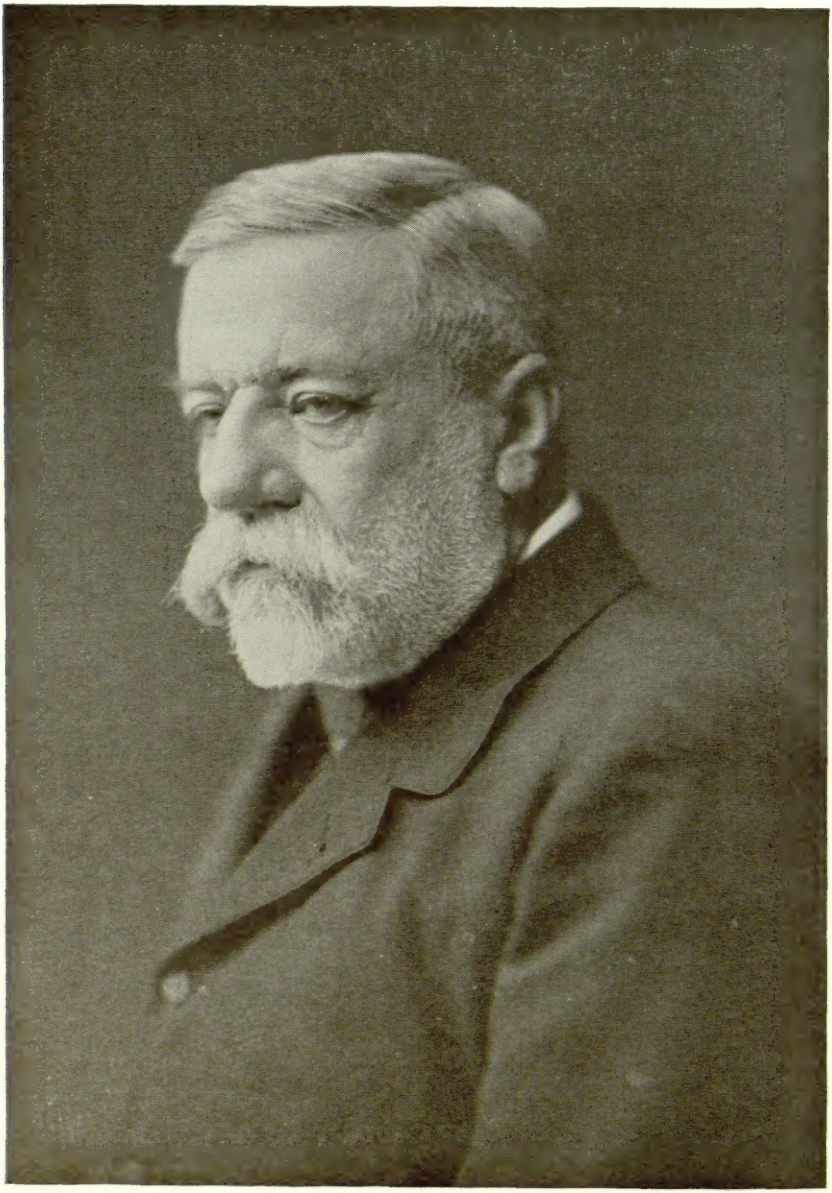
Sargent apparently first met Professor Cocks early in 1908. Unfortunately we do not know the content of the first letter Sargent received, for incredibly Cocks's incoming letters were not kept together, and only occasional letters or paragraphs from them may be found pocketed with herbarium specimens in the Arnold Arboretum. Professor Sargent quickly detected the aptitudes and values of his newfound correspondent, for his 302 letters to Cocks, reproduced here, were written sometimes daily, once two in a day, and with few long intervals, until twenty days before Professor Cocks's death on November 21, 1926. Sargent himself died four months later, on March 22, 1927.

Reginald Wodehouse Somers Cocks was born August 31, 1863, at Papworth, Worcestershire, England. He attended Trinity College, Cambridge, where he took the M. A. degree, in 1889, with first honors in classics. His interest in Latin persisted through his lifetime. There is a letter from Benjamin Lincoln Robinson, Curator of the Gray Herbarium, dated February 13, 1917, thanking Professor Cocks for his estimate of a paper which contained some Latin with which he disagreed. In this Dr. Robinson wrote, "I have no doubt that you are entirely right that my Latin contains various slips."

Although there are Cocks specimens in the Tulane Herbarium labelled "Feliciana, March, 1892," and "Feliciana, April, 1895," as well as some collections made in 1897, Professor Cocks's active botanizing began in March, 1898, and continued through that season. On May 27, 1898, he presented his first paper at the meeting of the Louisiana Society of Naturalists on *Selaginella apus* [*S. apoda*] growing in profusion at Mandeville, Louisiana. The Society had been organized July 3, 1897, and incorporated May 1, 1899, with Professor J. H. Dillard as its first president. "Mr. R. S. Cocks, M. A." is listed as a member of the executive committee for the year 1898–99, at the time he was an instructor at Boys' High School in New Orleans. Cocks and Professor George E. Beyer of Tulane completed a series of "excellent lectures on botany and zoology" given under the auspices of New Orleans Free Lecture System, according to a report in the *Gulf Fauna and Flora Bulletin* for June, 1899. June, 1899, included trips as far afield as Lake Charles prairies and Selma, Alabama, the home of Mrs. Cocks, and August, excursions to Alexandria and vicinity. From 1900 on, year after year, regular field trips, with special attention given to the woody plants, were made into all sections of the state. Cocks, like another Englishman, Philip Henry Gosse, first arrived in Canada from England



REGINALD WODEHOUSE SOMERS COCKS



CHARLES SPRAGUE SARGENT

but evidently did not stay in the north. A few herbarium labels suggest that he may have arrived in New Orleans as early as 1890 but this evidence is not wholly trustworthy. On other occasions specimens from opposite sides of the state carry the same month; yet it is highly unlikely that in those days he could have moved about so rapidly. Cocks generally recorded only the month and the year on his labels, and did not number his collections. Professor Sargent subsequently numbered some sheets for easy reference. For example, a *Carya* collection from Clear Lake, Natchitoches Parish, May, 1909, later became number 1765; another from Bayou Lacombe, St. Tammany Parish, across the state, also May, 1909, is number 1766.

After a year as Professor of Botany at Louisiana State University, 1906–07, Professor Cocks moved to Tulane to occupy the newly created Ida A. Richardson Chair of Botany. Mrs. Richardson took an active interest both in living plants and in books about them (our Tulane set of Sargent's *Silva* was her gift). It is notable that, on several occasions, Sargent mentions sending seeds or plants of foreign introductions, recently grown at the Arnold Arboretum, as possible additions to New Orleans gardens. This was in the spirit of Ida Richardson who is credited, and with good evidence, for the introduction of *Cocculus laurifolius*, *Siphonanthus indicus*, and other exotics into local gardens and patios. Through the years Professor Cocks supported the activities of the New Orleans Garden Society, and a volume of his collected papers was presented to the Society by one of its members, Mrs. J. Leo Burthe. Over and beyond his lecturing to garden clubs and his teaching of botany classes (his lecture notes have survived) was his enthusiasm for searching out new plant records for Louisiana. Here Sargent found a devoted colleague. It is abundantly clear from his letters that Professor Cocks conscientiously ran the errands Sargent put to him. And the errands kept coming, *in extremis* with Sargent's advancing concern that the revised *Manual* might not be finished before his life was ended. The first edition of the *Manual* had appeared in 1905 and immediately corrections and additions began to accumulate in the desk copy. When another collector provided a range extension in Louisiana, Sargent wrote Cocks to verify it. Mattoon found *Pinus caribaea* [*P. elliottii* var. *elliottii*] in the Tangipahoa region, and Sargent wrote for Cocks to hunt for it in other parts of the state where it might have been overlooked. From these collecting trips Sargent recognized five new species or varieties of hickory, a new hybrid oak (*Quercus* × *cocksii*) from near Alexandria, a hawthorn (*Crataegus cocksii*) from near Winnfield, and a linden (*Tilia cocksii*) from near Lake Charles. Sargent accompanied Cocks on several field trips over the state, testing revised keys in the field, collecting specimens in flower and fruit, and following up old records made by nineteenth century botanists. The two men marked trees to return to for successive vouchers, especially the oaks where the yields of fruit vary from year to year.

The zeal of the plant collector and the comradeship of the botanists portrayed in the letters which follow may be gleaned from a letter by Ernest

Jesse Palmer (often mentioned in Sargent's letters) to Professor Cocks dated March 5th, 1926, the year of his death. Palmer wrote "With reference to the *Yucca louisianica* at Ruston L[ouisian]a, of which I sent you a small snap, I regret to say that I have no duplicate material. When I saw it and made the photographs I was travelling with Dr. Small in his truck (the famous "weed wagon"). I took some specimens, but as you know, flowers of these plants are very hard to dry, and as we didn't have much chance for changing dryers on the trip practically all of the material was spoiled, and I only managed to save enough for one meager specimen for our herbarium.

"I was sorry to learn that you have been laid up. Have had a bad cold myself the past month, but have managed to keep going. [Palmer lived thirty-six years after this bout.] Professor Sargent, I am glad to report, has been in much better health and has been at the Arboretum almost every day during the winter. He is truly a remarkable man."

ACKNOWLEDGMENTS

My thanks first, to Professor William T. Penfound, of the University of Oklahoma, formerly at Tulane, for insuring the preservation of the Sargent letters during his years at the University. To Charlotte Ponder for her careful typing of the manuscript, and to Nesta Dunn Ewan for her critical editorial eye and her assistance with the indices, I express my very real appreciation.

1

April 7, 1908.

My dear Professor Cocks:

I want to tell you what a very pleasant day I had in Shreveport, thanks to your letter of introduction. I saw the Mesquite and the *Gleditsia*, although they were not yet in flower. The *Gleditsia* is certainly very close to *Gleditsia aquatica*. There is only one plant of it. I should say now, without having seen the flower, that it would be best to consider it a variety of that species, although the longer pods and greater number of seeds is remarkable. Possibly other individuals will be found.

I noticed in Jackson Square, New Orleans, three or four small trees of what I thought to be an eastern Asiatic *Acanthopanax* which I did not recognize. Do you know anything about these trees, and can you dry some specimens of the foliage for me? Is it possible to find out where these plants came from? I am afraid they are not old enough yet to flower.

This short visit to Louisiana impressed me more than ever with the beauty and interest of the state and I feel very keen to get back and to visit those parts of the state which I have not seen, namely the region east of Baton Rouge and west of Vicksburg.

I hope another year we may be able to manage a trip together. It is a great pleasure to me to make your acquaintance and I hope that I shall hear from you again.

2

April 21, 1909.

You remember that you sent me a specimen of a *Tilia* from Shreveport which I told you was probably *Tilia americana*. I am satisfied now that it is not *Tilia americana*, and that it is perhaps *Tilia leptophylla* which you will find mentioned in Small's Flora. I very much want to get flowers of this Louisiana *Tilia* and to know something of its distribution in the state. The same plant appears to grow on the Red River in Arkansas. Can't you get your correspondents to look out for this tree in Louisiana and especially to obtain good flowering specimens as these have not, so far as I know, been collected?

I wish we were in the woods together now.

3

December 8, 1909.

I now expect to be in Boston at the end of the month and, if you are coming here, I hope you will stay at my house. You can reach Boston very easily from there and also the Arboretum. It would be a great pleasure to me to see you again and to have you as my guest. There are many subjects we ought to discuss about southern botanical explorations.

4

January 17, 1910.

I am very glad to hear that you got home safely and are enjoying warm weather again. Here we have had bitterly cold weather and a good deal more snow, and I am longing for Louisiana or some other country of a milder climate than New England. Many thanks for your package of plants.

#17 is certainly *Aesculus austrina*.

#71, *Sapindus Drummondi*.

#91, *Smilax lanceolata*.

The *Bumelia* from Slidell without fruit is *B. lanuginosa*. The others seem to be correctly named.

It was a great pleasure having you in Brookline.

5

April 8, 1910.

I write to say that I got home safely and to thank you again for all your kindness to me during my visit in Louisiana. I never had a better week or saw finer or more interesting trees, and we certainly must have another trip together before long. I understand that you will obtain flowers of *Aesculus Pavia* for us, flowers of *Crataegus* and *Persimmon* from Lucknow, and fruit of *Salix* from Shreveport and Bayou Sara. Any other specimens will be most acceptable.

I am curious to hear about the Willow at New Orleans. The Shreveport Willow grows at Fulton, Arkansas, and also at Allenton which is about

thirty miles from St. Louis and apparently is a common and widely distributed tree. I cannot believe that it is only *Salix nigra*. A little more study of Louisiana Willows is going to lead to all sorts of surprises. The trouble is we have all been taking too much for granted. I find that we have n't here a copy of Dodson's Bulletin on Northern Louisiana Shrubs. If you can get a copy of it for the library here, I shall be much obliged.

I hope you got home comfortably and found everything all right at home. The mud at Fulton was about three feet deep. I never saw such roads before, but it did not rain and I was fortunate in finding in full flower the Oak I was looking for. I had a good day at Allenton and found there at least five species of *Prunus*, all of which had been passing for *Prunus americana*, and so it goes.

6

April 21, 1910.

Glad to get your letter of the 18th. I am much interested in what you say about *Hamamelis*. Have you perhaps found a third species? The Missouri plant flowers in February and March in a region which must be several weeks earlier than Louisiana. The habit you describe, too, is different. The Missouri plant grows always in the sandy and rocky borders of small streams and spreads into large thickets by underground roots. I should judge from what you say that your plant has not this habit.

How about the Willows at New Orleans and also the *Diospyros* at New Orleans? Did you get the fruit of the Willow at Bayou Sara? I am anxious to hear fuller accounts of your trips since we separated.

It is a very early spring here indeed.

7

May 16, 1910.

I have yours of the 10th and will write you about the plants when they arrive. Pearl Island must be directly at the mouth of Pearl River. I think I have seen the name on old maps. If you have access to a copy of Bartram's Travels, notice what he says about it. I suppose you know that he went as far as Baton Rouge. I cannot think that there is any trouble in finding this island, and I have no doubt the Plum-tree is still growing on it.

I very much hope that you intend to pass August in this part of the world. We will try to give you as good a time as possible.

8

June 7, 1910.

Very sorry to hear that you had such a bad time on Campbell Island,[2] but the fact that you found no Plum tree there may save us a lot of trouble in the future. I have been very busy lately and have only just now been able to look at your plants. We shall send you soon the names of several of them.

[2] Lake Pontchartrain.

With regard to the *Hamamelis*, your plant from Richlands appears identical with the spring-flowering species from west of the Missouri River. Probably it is the same thing which grows at Alexandria, Louisiana. I do not feel so sure of the Covington plant. I collected it there myself and have always felt doubtful about it. We must try and get flowers or find out just when it blooms.

I find that Mohr in 1885 collected your *Lindera* at Opelousas. We have what looks like the same thing, too, from Georgia, and in Missouri there are plants with less pubescence than yours which seems to connect it with the northern form. I am inclined to think now that your plant will have to be considered a variety. Your fruiting specimen which we have was collected June 15th and of course before the fruit was ripe. You ought to try and get mature fruiting specimens.

The Richlands *Diospyros* certainly looks very different both in the character of its tomentum and in the shape of the leaves. I presume that the trees in the New Orleans swamps are the same thing, although the leaves are certainly less cordate and more like those of more northern forms but the tomentum seems identical. The thing now is to get the fruit and the mature leaves. I hope you will be able to manage this. We ought, too, to have mature leaves of the Willows which you collected, and also mature leaves and fruit of the different plums. This I am afraid will prove more difficult, but perhaps you will be able to manage some of them. Any hope from our friends at Shreveport in this matter?

The plum business is very difficult owing to the difficulty of getting material and finding good characters by which to distinguish the different forms. I hope you are arranging to be in this part of the world this summer.

9

June 13, 1910.

Your *Vacciniums* are, —

72, *V. Elliottii*,
79, *V. Elliottii*?
80, *V. stamineum*,
81, *V. vacillans*,
89, *V. stamineum*,
90, *V. vacillans*,
99, *V. glaucescens*,
101, *V. vacillans*.

This I believe disposes of your unnamed plants except the Willows and Persimmons, and it will take some time to work these up.

10

October 12, 1910.

Many thanks for the three lots of plums which arrived today in capital condition. I have to thank you, too, for the Persimmon fruit which came sometime ago. So far as the shape of the fruit of the two kinds is con-

cerned I see nothing very remarkable about it for the fruit of the common Persimmon shows as much or more difference in variation. The pubescence on the Persimmon, too, seems to be a very variable character. The fact that one form grows in water continuously, or nearly continuously during the year, and the other only on dry land is remarkable and we ought to find some other characters beyond the shape of the fruit to separate these. I think there is a difference perhaps in the time of blooming and possibly in the size of the flowers.

Is there any thing new in the *Salix* situation and have you foliage specimens for us?

I hope you are well and enjoying life, and have no University troubles on your hands.

11

December 14, 1910.

I am much obliged for your letter of November 28th (I am ashamed to see how long it has remained unanswered) and for the package of plants.

#8, Pearl River, is certainly *Asimina parviflora*. I do not know any *A. pubescens*.

#9, *C* vii. of Shreveport, is *Crataegus spathulata*.

#11, *C* iii. of Shreveport, is *Crataegus arborescens*.

#13, *Amelanchier canadensis* [var.] *tomentula* Sargent is the best I can do for this. It seems the same as the Covington tree.

#22 and #23, ii. and iii., Shreveport, *Crataegus spathulata*.

I cannot say anything about the plums yet; indeed I am more ignorant about them than I was a year ago, still we will do something with them sooner or later. As you know, it is an extremely difficult genus to collect, because they flower when there is nothing else to collect and the fruit ripens early when it is hot and botanizing is disagreeable.

I have never seen flowers or fruit of *Cephalotaxus japonica*, which seems to be an abnormal garden form with erect branches of some other species. If you have specimens of the flowers and fruit, we shall be very glad to get them.

Have n't you got a lot of Willow material for me? That southern Black Willow question is not yet settled. Indeed there is so much work to do in the south that I do not know which way to turn. I certainly hope to be down in your part of the world again this spring.

We have received through the Department of Agriculture a specimen of *Tilia* collected at Lake Charles which is perfectly glabrous and looks like *Tilia floridana*. We should investigate it.

We have had some cold weather and some snow, but it is not as bad as it was when you were here last year.

12

December 31, 1910.

I hope you are going to be able this winter to further investigate the Louisiana *Hamamelis*. I am describing the Missouri and Arkansas spring-

blooming plants as *Hamamelis vernalis*. The specimens from Covington collected by myself and by you and your specimens from Alto, Richland Parish are certainly different in the pubescence from the Missouri plant. Of course we have n't got any flowers of any Louisiana specimen. In the Gray Herbarium there is also a *Hamamelis* collected at Alexandria which I suppose is the Richland Parish plant. Why can't you take up this matter this winter and get flowers if possible from all these stations, or at least find out whether they do or do not flower in the winter or early spring?

13

January 9, 1911.

Very sorry indeed to hear that you are under the weather. Take care of yourself, pray, for there is lots of work ahead of you if we are ever going to solve all the mysteries of Louisiana trees. It is my hope and intention to pay you a visit this spring either before or after I go to Texas, or at both times. I have not formulated my plans yet.

Mr. Rehder here is working over the North American species of *Malus* and is describing a number of new species and forms. On April 3rd, 1885, I collected at Pinnyville [Pineville], Louisiana, which is just across Red River from Alexandria, specimens of an Apple growing in a glade in the pine woods which we used to refer to *Malus angustifolia*. I do not believe it is that species and probably it represents an undescribed one. It ought to be looked up and fruit should be collected. Of the true *Malus angustifolia* we have from La. two specimens, one collected by me March 26, 1886, at Opulusas [Opelousas], and one collected by you at Bayou Lacombe, No. 1779. I do not remember where Bayou Lacombe is. Both these Louisiana specimens differ from the specimens of the southeast, Georgia, Florida, etc., by the pubescence on the leaves and petioles. I should suppose *Malus angustifolia* would be a common Louisiana plant, especially in eastern Louisiana as we have specimens from Pearl River Valley in Mississippi. This is a thing which ought to be looked up.

I have just finished describing seven species of *Prunus* from Arkansas and Texas, and I do not believe that these descriptions cover any of your Louisiana trees. *Prunus* is a genus which certainly has got to be more carefully studied in Louisiana.

I think we have pretty good material of that pubescent Willow but I hope you will be able to collect Willows wherever you see them in Louisiana as we want more material and more information about these different forms of the Black Willow. I am suggesting calling the Bayou Sara tree *Salix nigra* variety *altissima*, for as it grows at Fulton, Arkansas, this is the tallest of all the Willows I have ever known anything about.

The amount of material we have representing Louisiana woody plants is still unsatisfactory and my knowledge about them is even more so. I am counting on you for a good deal of help.

With kind regards and best wishes for the New Year, I am

14

February 10, 1911.

I have today your letter of February 6th and the specimen of Oak. This looks to us like the tree which they call in England the Lucombe Oak and which is supposed to be a hybrid between *Quercus Cerris* and *Quercus Suber*. Hope you will get plenty of Willow material and the Witch Hazel flowers if possible.

To show how poor we are in Louisiana plants I could not find this morning a Louisiana specimen of Liquidambar in our herbarium.

I am going to Florida on the 18th for a few days and I shall return home before going to the southwest. I want to go to Texas before Louisiana, so it will be April, I suppose, before I reach New Orleans. I do not care much where I go in the state but we ought to look up that *Tilia* at Lake Charles; and I should like to go, too, to some more places east of the Mississippi. Opulusas [Opelousas] is always very interesting to me, so I shall be entirely at your disposal.

15

February 15, 1911.

I write another line to remind you that there is a lot to do on *Prunus* in Louisiana in the hope that you may be able to get good flowering material from trees so located that we may get fruit from them later in the season. This is one of the most difficult groups to work up as the fruit is hard to preserve, and it flowers so early that it is necessary to make special trips to get them.

16

March 6, 1911.

The two specimens have arrived. Certainly this is not the same as my spring-blooming Missouri and Arkansas species which has the inner surface of the sepals bright red. This plant of yours is remarkable in the small size of the flowers and of the fruit which is not more than half the size of the ordinary *Hamamelis* fruit. This may be the variety *parvifolia* of Nuttall, a variety afterwards taken up by Torrey & Gray but dropped by recent authors. Judging from the time it flowers, your plant may represent a third species; at any rate we have got to know more about it.

Will you be on the lookout for a yellow-twigged Tree Willow which is common in eastern Texas and which you ought to find in the Shreveport and western Louisiana region? This is either a species or a good variety of *Salix nigra* and we want to know more about it and to get more material.

I am hoping now to go to Texas on March 15th and to meet you at Lake Charles on my way back, but I will write again before I leave home.

17

March 14, 1911.

I am glad, or perhaps really sorry, to hear that Plum trees are so abundant in western Louisiana. I am leaving here on Thursday, the 16th, and

go via St. Louis to Texas. I cannot exactly fix now the date of our meeting at Lake Charles but I will telegraph you from Texas as soon as I know. I may not be able, however, to send word very long in advance, so I hope you will be ready to start at short notice as it will be horrid to be tied up alone at Lake Charles. Will you send me a line to the post-office at San Antonio in about a week from today and tell me if everything will be all right? I think it would be an excellent plan to pay Tracey a visit as I have never met him and possibly something might be gained by doing so.

18

April 4, 1911.

I got home safely and very comfortably as that was an excellent train, to find here the coldest April 1st on record. The ground is still deeply frozen, new ice has formed on the ponds and there is not a sign of leaf or flower of any kind. I wish I were back with you in New Orleans.

Our Lake Charles *Tilia* differs from *Tilia leiophylla* in the absence, or almost absence, of pubescence and in the serration of the leaves. *Tilia leiophylla* has generally rather coarsely serrate leaves, but in all the Lake Charles specimens the teeth are reduced to mucros. Still I think we must consider our plant a form of *Tilia leiophylla*, especially as we have specimens from Fulton with practically glabrous leaves. It will be interesting and important, however, to get flowers and fruit from Lake Charles.

I have specimens of all the Louisiana *Crataegus* described by Beadle and I feel quite sure that the Lake Charles *Crus-galli* tree which we saw is undescribed. I hope you won't fail to get the fruit, and I greatly regret that we did not get flowers or make specimens. I am quite impatient for the specimens of the *Crataegus* from Covington to arrive for I cannot believe that this is *C. brachyacantha*. The bark is different and the peduncles and pedicels are much shorter than those of that species. If it turns out to be new, this is one of the most interesting *Crataegus* discoveries that I have made in years. *C. brachyacantha* is common at Minden and Munro[e], and I see that Bush collected it at Natchitoches.

As you perhaps know four *Crus-galli* species were collected by Beadle near Opelousas. My *C. edita* appears also to grow there, and of course *C. berberifolia*. About Shreveport there are several *Crus-galli* species, but I think you will find the entire western border of the state full of species of this group.

I am very much interested in that *Crataegus* with white bark, cordate leaves and partly grown fruit which we found on our drive from Covington near the schoolhouse. I thought it might be *C. silvicola* but the leaves as I remember them are much too cordate for that species.

I feel quite sure that the Covington *Viburnum* is *V. pubescens*. *Viburnum dentatum* seems to be confined entirely to the Appalachian region. I ought to see what you have taken for *V. molle*. I hope you won't forget good specimens from any localities of the Louisiana *Sambucus* as this genus is pretty puzzling.

I have ventured to order and send to you a telescope for your driers after the pattern of mine, which has proved very satisfactory in strength and lightness. Please accept it in memory of the pleasant days we have passed together in Louisiana. Notice, too, that I have had it made much deeper than my own and draw from this fact your own conclusions.

I hope to hear from you very soon about your work since I left. If *Prunus* and *Crataegus* are to be finished within three years there is not a moment to lose.

19

April 6, 1911.

The *Vitis* which we collected at Lake Charles is *V. canescens*. You collected the same thing two or three years ago at Richland Parish and called it *V. labrusca*. I do not see that the books credit Louisiana with *V. canescens*.

The Highbush Blackberry of which we saw so much at Lake Charles and Covington is *Rubus Andrewsianus* of Blanchard.

20

April 19, 1911.

The package of plants has arrived and I am very glad to see them. The *Malus* from Covington appears to be *Malus angustifolia*, but we want to get good fruiting specimens of this and a handful or two of fruit. It is an entirely different plant from the one at Pineville. This I hope you have looked up for I very much want to get the fruit, having good flowering specimens already.

The *Viburnum* from Glen Gordon is not *Viburnum pubescens* but *V. scabrellum*.

The *Crataegus* I cannot distinguish from *C. brachy*[*a*]*cantha* and I believe we shall find it has blue fruit.

The *Euonymus* from Covington is *E. americanus*.

What you call *Vitis canescens* from Glen Gordon is *Vitis cordifolia* and different from the Lake Charles plant which I told you by mistake was *canescens*. There is no *Vitis canescens*; it should be *V. cinerea*. The Covington plant seems different from that from Lake Charles.

The shrubby *Vaccinium* from Covington is *V. stamineum*. You have also collected this from Shreveport. It is desirable to get good fruiting specimens of this.

The *Rubus* from Claybourne is the same as the tall-growing species from Lake Charles. The oldest name for this is *R. argutus* of Link, which must supersede *R. Andrewsianus*. The little *Rubus* from Glen Gordon with prostrate stems is *R. trivialis*. The Dewberry from Lake Charles with the large flowers and fruit is, I feel satisfied, an undescribed species.

I hope you found the *Malus* from Opelousas which, if it is *angustifolia*, is a very tomentose form of it.

I hope you are going to be able to clear up many doubts and mysteries

this season and that you will make good headway with *Prunus*, *Malus* and *Crataegus*.

21

June 10, 1911.

Do you know anything about the writer of the enclosed? Possibly he may be made useful as a collector or in connection with your proposed garden.

I shall hope to hear from you soon again about the various plants in which we are interested.

22

July 22, 1911.

The enclosed may interest you, although I daresay you are in communication with this lady.[3] I suppose it was her uncle who was associated with Riddell. I know of no other publication by Carpenter.

How are you getting on and what is the Plum situation? I hope good, for in Texas and Arkansas there is no fruit whatever. And how about *Malus*, *Crataegus*, etc.?

I hope that you are not worn out by the heat and that I shall soon hear from you again. I cannot think that it has been hotter in Louisiana than it has in Boston this year. We have never known anything like it or experienced such a drought.

Let me hear from you when opportunity offers.

23

August 26, 1911.

How are you and what is the botanical situation? I hope that you won't be too late for the fruit of *Aesculus Pavia* from Mandeville as we want it for a subject for one of Mr. Faxon's plates. I think it would be well to gather it before it is ripe, although it should be fully grown. Perhaps the best way would be to wrap up a fruiting branch in paper and send it by mail. This might give better results so far as the drawing goes than a dried specimen.

Any word of the *Malus* from Pineville which we are very keen to get hold of? *Prunus* in Texas and Arkansas is behaving very badly this year and there is no fruit on any of the plants. I hope it is doing better in Louisiana.

I am just back from a short trip to Colorado where I had a few good botanical days and from whence I returned via the Great Lakes, which I found a most interesting trip.

24

December 19, 1911.

It is a long time since I have heard from you. I hope you are well and that the botanical situation is not too much for you.

[3] Mrs. SLAUGHTER of Ruston, La., who provided information on WM. M. CARPENTER for Professor Cocks (cf. Tulane Graduates Mag. 3: 122. 1914).

I was looking at Louisiana *Crataegus* in the herbarium the other day and it is astonishing what a small amount of material we have from that state and how little I know about it. The Plums and Apples, too, are weighing rather heavily on me. Have you got any more plants to send us from this year's collecting?

I hope you will have a very pleasant Christmas and a happy and prosperous New Year.

25

February 3, 1912.

It is a long time since I have heard from you but I hope this does not mean that you are not well. I hope to be in Louisiana coming from Texas early in April and I want to meet you somewhere and make another trip with you. I hope you will be able to manage this.

The Louisiana *Prunus* situation is in bad shape as only fragmentary material has so far been collected. I think it is desirable that you make a Plum journey early and before I get to Louisiana, otherwise we shall miss them again. For example, numbers 1 and 2 of the Butler plantation were well out of bloom on March 28, 1910; from Laurel Hill to Covington we have leaves only. #1 from Clear Lake was out of bloom March 30th. Shreveport plants were all out of bloom April 1st, and specimens collected at Opelousas were out of bloom March 20th. Bush's collections at Natchitoches April 1st, 1909, were long out of bloom.

I should think it would be desirable to look over the state for Plums as early as March 10th, or perhaps even earlier in the south. The trees should be carefully marked to insure mature leaves and fruit later in the season.

I want very much to go with you to that place north of Alexandria to look for the *Malus* which you have n't been able to find. I am very sure it is an undescribed species.

As for Louisiana *Crataegus* the situation, I hope, is not hopeless but I think we must confess that we are making very little headway with it. Please let me hear from you.

26

March 28, 1912.

I am still pretty shaky but the doctor tells me that I can probably get off in a week or ten days for Louisiana. I do not know about the trains yet, but would n't it be feasible for us to meet say at Munroe and drive from there to Alexandria? How long would this take and would it be a feasible trip? It would at least show me a new country. Or I could perhaps get to Alexandria quicker than I could to New Orleans, look up the Apple across the river, then go on to Shreveport and Natchitoches, and return to New Orleans.

Let me have an answer to this if you can before I start. If not, I will telegraph you when I find out if I can really go and tell you when and where I will be.

27

October 16, 1912.

Returning from a short journey in Missouri I find your letter of September 26th and the package of specimens which you have been good enough to send us.

I cannot do much with the *Crataegus* unless you have the notes on the color of the anthers. This is essential to a correct determination of these troublesome things. Have you also fruit? I can say, however, that No. 1 N.O. is *C. viridis* and xi. and xviii. of Natchitoches are *C. brachyacantha*. *C. brachyacantha* was the species which we found so abundant a year ago last spring near Covington. The *Malus* and *Vacciniums* I will write about as soon as the specimens are mounted.

28

February 18, 1913.

We have a specimen of a Maple collected by you at Natchitoches April 27, 1911, with fully grown fruit. It is a very distinct form of the Sugar Maple and perhaps an undescribed species. There is nothing like it in our herbarium. I am writing to you now to suggest that as this tree had fully grown fruit on the 27th of April it must flower very early, probably some time before we get to Natchitoches. It is desirable if possible to get flowers this spring as we may want to publish a plate of it if it turns out to be new. Do you remember the tree? Is it common, etc.? The nearest Sugar Maple to this station which we know is at Fulton, Arkansas, and there is another at Boerne, Texas, which must be four or five hundred miles away.

What is the prospect of the season, is it going to be early or late? I will let you know a few days before I start for New Orleans.

29

February 25, 1913.

I am much obliged for the specimen of Maple which arrived today. I think it is safe to refer it to *Acer leucoderme* Small.

Please write me again about the season and how vegetation is coming on.

30

April 12, 1913.

We arrived in New Orleans safely but Tracey failed to turn up there. From New Orleans we went to Natchez, staying there about thirty-six hours and then came home from Chattanooga, arriving here last night. I have been quite anxious about you for I am afraid the rain which started in after we left Natchez has made a great deal of trouble in the Red River Valley and that you are prevented from doing some of the work you were going to do.

I have n't had time to do much with plants since I got home but the Opelousas *Malus* seems to be very near *Malus ioensis* var. *Palmeri*, and

the species from Win[n]field to be a form of *Malus angustifolia* with remarkably acuminate leaves. It can hardly, however, be specifically distinct. At Natchez we found *Hydrangea quercifolia* very common. Has this ever been found in Louisiana where it ought to grow I should think, but we have no specimens from anywhere west of Alabama? I had supposed that it was an Appalachian species but finding it at Natchez makes me think it may grow south of Natchez and possibly across the river. I also found at Natchez what I believe is my *Aesculus splendens* although I have n't seen the fruit yet and I think that we found the same species at Winnfield. If so this is rather a fine plant for the Louisiana flora. That little *Viburnum acerifolium*, if it is that species, is certainly interesting for this appears to be an Appalachian species, at least we have no specimens taken west of Alabama and none from west of the Mississippi River. These ought to be looked up. Although *Quercus breviloba* is credited in my Manual to Louisiana I do not find that we have any specimens of it from that state. I should suppose that if it occurs there at all it would be about Shreveport as it is common at Fulton.

I have n't taken time yet to find out the things which you have n't sent us, but I will write you again next week. Please let me hear what happened to you after we parted. I have n't seen anything so fine anywhere on this journey as the woods at Opelousas.

31

April 15, 1913.

A few of the Louisiana plants which we do not have in the herbarium are *Mimosa strigulosa*, *Parkinsonia aculeata*, *Desmodium* if there are any woody species, and *Erythrina herbacea*. Have you ever seen this last assume the habit of a shrub or small tree, in southern Florida perhaps a tree of considerable size?

Of *Quercus laurifolia* we have only the specimen with young leaves collected by us at Lake Charles two years ago. I should be glad to have fruiting specimens from Lake Charles and from other parts of the state.

I will send you a list of other Louisiana desiderata as soon as I have time to look them up.

You are O.K. with *Prunus Munsoniana*.

32

April 15, 1913.

As the copy of your paper, for which many thanks, appeared this morning I am afraid you had to shorten your trip and were unable to get to several of the places you hoped to visit. Too bad!

It looks as if we were never going to get at the bottom of the Louisiana *Crataegus*. Mr. Rehder, who is working up *Malus*, has made a new variety of *M. ioensis* which he calls *creniserrata*. The type for this is the Pineville plant. He refers to it also the Crowley and Opelousas plants. In regard to Crowley I find that you are right and that we have fruit from there and

some fragmentary leaves. I shall be very glad to get leaves collected now with the young fruit, especially leaves of vigorous shoots as it is always important to collect these. Your *Malus angustifolia* from Covington, etc., is behaving very badly and does not seem to belong to the typical form of that species as it turns out to have hairy pedicels, etc. I wish you would collect some more material of this plant from that region with good vegetative leaves, etc. If *Malus angustifolia*, which we have always believed to be perfectly glabrous, is going to behave in this way it will make additional trouble for us.

33

April 19, 1913.

As you know, Louisiana was not credited in my Manual for *Avicennia nitida*. We have a specimen from you gathered at Grand Isle. Can you give me the range of the species in Louisiana, that is the range east and west on the coast? Is it always shrubby in Louisiana or sometimes a tree? I do not know where Grand Isle is, but perhaps you will tell me.

34

April 21, 1913.

As I wrote you, we consider the Pineville plant the type of *Malus ioensis* variety *creniserrata*, nov. var. Rehder. The Natchitoches plant which we have from you in flower only is referred to this variety although it looks a little different. The Opelousas and Crowley plants we now refer to *Malus ioensis* var. *Palmeri* Rehder. The type of this variety is in southwestern Missouri, but this form is common in southeastern Missouri and in Arkansas.

You understand that what we have always called *Malus angustifolia* now has to be called *Malus coronaria*. Rehder makes a new variety of this, variety *puberula*, the type of which is the Winnfield plant. I found exactly the same thing at Natchez and we are referring to this variety all your specimens from eastern Louisiana. So far as our specimens show we have no typical *M. coronaria* or *angustifolia* from Louisiana, all your specimens having more or less pointed leaves and hairy pedicels, while in the real *coronaria* the leaves are usually rounded at the apex and the entire plant is glabrous. As I wrote you the other day, I hope you will get more material from eastern Louisiana.

Now in regard to the *Crataegus* which we collected: Opelousas, #1, a *Viridis* species, by roadside, distinguished from *C. viridis* by the bark. Fruit needed.

C #2 agrees well with *C. tersa* of Beadle.

C #3, the *Crus-galli* species with small corymbs, does not fit in with any described species. Of course we want fruit of this. C #4 we were badly fooled by; it is not a *Crus-galli* at all but *C. brachyacantha*.

C #5, a *Viridis* species. No flowers.

Winnfield #1. I don't know this.

#2. This was the small slender tree near the quarry, certainly a distinct new species. Fruit certainly should be obtained.

Lake Charles. The thornless *Crus-galli* in yard on roadside to English Bayou. I don't know this.

These are all we collected this year. I do not think there ought to be much trouble with the Louisiana species if we can only get material for, with the exception of *C. brachyacantha*, *apiifolia* and *spathulata*, they all belong to the *Viridis* and *Crus-galli*, with the exception also of that plant we found in western Louisiana which belongs to some other group. It looks something like *C. silvicola* of Beadle. I collected a number of years ago specimens of a good many *Crus-galli* forms from Mendum [Minden] which I think is a field which should be investigated.

I will write you again about *Crataegus* in the course of a few days. I am very anxious to hear from you and what happened to you after we separated.

35

April 30, 1913.

Too bad that the weather is so much against us; still if we keep on I think we shall get to the bottom of our Louisiana problems.

I understand that Robin's Flora is a supplement to his general Travels in three volumes, and if the librarian of the Howard Library can get us a copy of the whole work I shall be greatly indebted to him and to you.

We have a wonderful season here this year and have never had so many flowers before.

Better luck next time you start out!

36

May 20, 1913.

I have this morning the package of your plants, for which many thanks.

Carya Nos. 1 and 3 from Bernice is *C. alba*. No. 2 from Bernice I don't know. The *Carya* from West Feliciana, Nos. 1, 2 and 3, I don't know. No. 4, *C. alba*. No. 5, *C. cordiformis*.

When I say I don't know I mean that I don't feel sure about this without more material. Of course we ought to have fruiting specimens in the autumn.

Acer appears to be *A. floridanum*, and all the specimens of *Malus* can be referred, we think, to *M. coronaria* var. *puberula*. The Selma *Ilex* is *I. longipes*.

Have you ever found the *Hydrangea* west of the Mississippi River? There is still, I think, two Maples and another *Malus* to come from Natchitoch.

I never heard from that banker whom I asked to send the *Malus* specimen. Can't you stir him up on the subject?

Mr. Harbison, who collects for the Arboretum in the southeast, has been to Selma this spring to look for the *Molles* species of *Crataegus* you told

me about and for the *Ilex*. I told him that you had a plantation near Selma and he apparently lost a good deal of time in trying to locate it. He even went to the court-house to look for a Cocks owning property in that part of the world. I suppose the trouble was that the plantation does not stand under your name but under that of some member of your wife's family. Harbison will be back there sometime this year and I wish you would write me how he can find your plantation and also the exact localities for the *Molles* species of *Crataegus* and for the *Ilex*.

I hope the world is treating you kindly and that you are coming north this summer. There is a lot of work which ought to be done in Louisiana in the autumn.

37

June 18, 1913.

I am glad to get your letter. The Holly from Selma is *Ilex longipes* of Chapman.

The last Maple you sent from Natchitoches appears to be *Acer leucoderme*, but we also have had from the same region from you in previous years what must be *Acer floridanum*; in fact these Natchitoches Maples do not behave very well and show a tendency to too much variation. *Acer nigrum* from there we have never seen yet but I hope you will be able to get it this autumn.

I am going to write you in a few days about the Louisiana things which especially need looking up this autumn. I am glad in the meantime that you are in such a good field as you report Selma to be. By all means send the Plums and collect everything woody you can lay your hands on, and please pay especial attention to the Hickories. Harbison has been to Selma two or three times in the interest of the Arboretum and will be back there probably this autumn but I am afraid not until after you have left.

I gather from your letter that you don't expect to come north this summer. I wish you would let me know about this and, if you are coming, when you will be here and how long you expect to stay. I hope in any case nothing is going to interfere with work in Louisiana this autumn.

38

June 25, 1913.

I have your note of June 21st and the box of Plums. I do not know this plant if it is not a late-ripening variety of the Chickasaw. I suppose you are making specimens. I have made out the following memorandum of plants in Louisiana which need looking after this autumn:

Opelousas.

Crataegus #1, a *Viridis* species on the bank by roadside east of Opelousas.

Crataegus #3, low rich woods fifteen miles west of Opelousas, a tomentose *Crus-galli* species.

Crataegus #5, a *Viridis* species in low wet woods, fifteen miles west of Opelousas.

The *Quercus*, like the Post Oak, but growing in low wet woods. Mature leaves and fruit of this should be collected.

Quercus ludoviciana, new hybrid, Sargent. Our hybrid tree fifteen miles west of Opelousas. I have described the tree with the above name in the new part of Trees and Shrubs. Fruit and mature leaves needed.

The red-flowered *Aesculus* in woods east of Opelousas, perhaps *Aesculus Pavia* but the leaflets are too pubescent below.

Malus.

Mature leaf specimens of the species in the woods fifteen miles west of Opelousas, probably *M. ioensis* var. *Palmeri*.

Hickory #1, large tree with smooth bark in woods east of Opelousas. The trees marked 3 and 4 are probably this form.

Hickory #2, large tree in woods east of Opelousas, with rather rough bark.

Winnfield.

Crataegus #1, the *Crus-galli* species by roadside close to town.

Crataegus #2, the very tall slender tree near quarry, no doubt a new *Crus-galli* species.

Malus coronaria, var. *puberula*. The type of this variety is from Winnfield. Fruit and leafy shoots are needed.

The red-flowered *Aesculus* which I believe is my *Aesculus splendens*. It is important to get the fruit of this for if it proves to be *Aesculus splendens* this is a new species for Louisiana.

Hickories.

Two species in woods near quarry.

A large Hickory in yard in Winnfield. This is probably an undescribed species.

Lake Charles.

Crataegus #1. On road to English — Irish? — bayou. The tree is in a yard, about fifteen feet high, with stem a foot in diameter and wide-spreading branches.

Hickory. The tree with pale close bark in the low woods along the river, common. The young leaves are bright red. This is probably an undescribed species and perhaps the same as one of the Hickories in the woods east of Opelousas.

We should have autumn leaves and fruit of the following Hickories: Bernice II, West Feliciana; Nos. 1, 2 and 3, Bayou Lacombe, 1785, May 1908; and #1766, May 1909.

We need good material of *Malus* from Crowley and of the two forms at Natchitoches, with fruit and leaf shoots. Also from Natchitoches more specimens of the three forms of *Acer*, *A. floridanum*, *A. leucoderme* and *A. nigrum*; the last I have never seen.

I have a great deal of incomplete *Crataegus* material from Shreveport, Munroe, Richmond, Natchitoches and Crowley, but it seems to me that it would be better to concentrate this autumn on the things which we saw this spring and which I have enumerated above, and try and get these finished up. If we don't begin pretty soon and finish some of these doubtful Louis-

iana trees we shall never get anywhere I am afraid. There are apparently more species of *Crataegus* at Natchitoches than anywhere else in Louisiana and of course it is desirable to collect fruiting specimens and number the trees this autumn if they are in good condition with the view of completing them in the spring, but as I have already said it is most important to finish up the things which we got this spring.

Wistaria frutescens and *macrostachya* appear to run together and we are inclined to consider the latter a variety of the former. I certainly collected the two plants at Covington. We have no fruiting specimens of *Wistaria* from Louisiana and if you come across any this autumn I wish you would make specimens from the different localities.

39

July 9, 1913.

Many thanks for the second lot of Plums which have arrived safely.

I have n't seen Harper's Alabama book yet but I believe I have ordered it. It is not perhaps surprising that it is n't complete as his botanical observations are chiefly made from the windows of moving trains.

Have you seen Small's new edition of The Flora of the Southeastern States? I cannot see that he says much about Louisiana plants in it, and he has certainly missed all the interesting new things in the way of trees and shrubs that have been found in the south in late years. It does n't seem to me that this book, in spite of its great size, adds much to our knowledge of the subject.

I do not believe it is any hotter in Alabama than it has been here during the past week and I hope it is n't as dry there as it is here.

40

July 18, 1913.

I have yours of the 18th and the lots of Plum fruit, for which many thanks. Sardis must be a great Plum country, and I hope you are drying leaves and making notes of the different forms.

I am off tonight for Puget Sound, but shall be back at the end of three or four weeks. Anything you send in my absence will be taken care of.

I return Hedrick's letter. His statement confirms my belief that it is impossible to tell much about Plum trees from herbarium specimens alone. I cannot believe that *Prunus Watsoni* grows in Alabama.

41

August 15, 1913.

I am just back from the Pacific coast and find here your letter of July 17th and the leaf specimens of the Sardis Plums.

We feel quite sure that your No. 7 is not *P[runus] pennsylvanica*. I do not know what it is but it looks like a new species of Cherry. You better send some notes about the size, habitat, etc., of this tree. No. 8 is not *P. mitis* and also looks as if it might be a new Cherry. No. 5 is, as you say,

P. umbellata, and I think you are right in referring No. 6 to *P. munsoniana*. I am afraid I cannot throw any light on the other specimens.

The Selma region seems to be a terror for Plums and I hope we shall get to the end of them sometime.

I hope you are all right for the autumn campaign in Louisiana for it is important to clear up some of these Louisiana mysteries. By all means collect Crabapples from the Selma region. There is probably one new species there with leaves very pubescent on the lower surface.

I've just written Harbison to suggest that he go at once to Selma & look over the Plum field with you.

42

August 27, 1913.

W. H. Lamb of the Forest Service of the United States pronounces an Ash collected by Dr. J. S. Schenck May 1901 in a Palm Swamp, New Orleans, and previously referred to *F*[*raxinus*] *profunda*, to Britton's *F. Michauxii*. Do you know anything about this? Specimens of *F. Michauxii* which I have seen look distinct. Leaflets on the under surface are slightly pubescent and the wing of the seeds is short and broad. This may be a good species.

43

September 24, 1913.

I find that from southern Missouri I can best reach Louisiana at Munroe and I suggest that we meet there instead of at Shreveport, then from Munroe we can go in either direction. It looks as if I could be there on the 8th or 9th of October, but I will telegraph you two or three days in advance of my arrival. I think, however, you had best be there on the evening of the 8th.

44

September 30, 1913.

In looking over the plant you recently sent we find that the *Ilex*, a small shrub from the banks of the Alabama River, is *Ilex monticola*. There is a second specimen of this species from Sardis. The *Bumelia* is *B. lycioides*.

Vitis No. 1 is *V. cordifolia*.

Vitis No. 2 is *V. aestivalis*.

I am leaving on Thursday and shall be able to telegraph you probably from St. Louis two or three days in advance of my reaching Munroe.

45

October 20, 1913.

We had a couple of good days with Harbison on Mobile Bay and finally got home on Friday. Hickories are very abundant on the shores of the Bay and there is but one species there, a Pignut, which shows remarkable variation.

The Winnfield *Sambucus* is *S. canadensis* variety *submollis* Rehder, which appears to be the common form west of the Mississippi from Missouri to Texas. The *Sambucus* which we collected at Opelousas and which appears to be common in the neighborhood of New Orleans and along Mississippi Sound is *Sambucus Simpsonii* Rehder, a species first distinguished in western Florida south of Tampa Bay. It is sometimes a small tree and appears to be very common in all of southern Louisiana, Mississippi and Alabama. The Florida plant, as I remember it, did not have the bright red petioles, and these were not noticeable in plants which I saw about Mobile. The very shining leaves are very unlike those of any form of *Sambucus canadensis* and this I think is a good addition to your Louisiana flora.

I wish you would dry me a specimen of what they cultivate in New Orleans as Rose of Sharon as I do not seem to be able to place this plant from memory. I hope, too, you will send specimens of the different forms of *Ligustrum* which they cultivate in New Orleans with deciduous leaves, and the *Araucarias*. Indeed we should be glad of herbarium specimens of any of the uncommon trees and shrubs cultivated in New Orleans as there ought to be representatives in this herbarium of every woody plant cultivated in the United States.

I will write again soon about some of your other plants. I hope you have got over the hardships of Opelousas.

46

October 25, 1913.

The *Ilex* with solitary fruit on short pedicels which we collected at Winnfield is *Ilex monticola*. This is the first time that we have had any indication that this species grows west of the Mississippi River, and Small gives its western locality as Alabama. Perhaps this therefore is a new addition to the Louisiana flora.

I think we shall have to call the *Viburnum* which we supposed might be *V. prunifolium* *V. rufidulum* as the buds are covered with the rufous tomentum of this species which varies on the petioles.

I find that there is n't a specimen of *Persea borbonia* from Louisiana in our herbarium. I suppose it is a common enough tree in the state and I wish you would let us have a specimen. I should be much obliged, too, if you will sometime take a look at *Acer Drummondii* as it grows in the swamps and give me some idea of the size this tree attains under favorable conditions, both in height and trunk diameter, and also some notes on the character of the bark. I don't remember that I have ever been close to the tree and if it is to be considered a species I must have more facts about it than I have at present.

47

November 10, 1913.

We have sent the plants named on the enclosed list to Mr. Marshall, Superintendent of the Audubon Park, to whom I also send a list.

Cupressus funebris is an important Chinese tree which ought to do well in New Orleans, and I hope a good place will be selected for it. I don't know as there is much to say about the other plants.

I will write a line also, as you suggested, to Mr. Morgan, President of the Audubon Park Commission.

48

November 18, 1913.

I have your letter of November 13th as well as the Louisiana specimens of Hickory. Of Nos. 2, 3 and 7 from West Feliciana there are no nuts, No. 2 of course being *C. cordiformis*. Of No. 3 of Grand Ecore there are no nuts.

No. 6 from Natchitoches looks like *C. pallida*, and I think No. 2 from Natchitoches is the same although there are no nuts of this. No. 7 from Natchitoches is *C. ovata* approaching variety *Nuttallii*. No. 8 Natchitoches looks like *C. ovata* but there are no nuts. No. 9 Natchitoches is *C. myristicaeformis* but there are no nuts and we should be glad to have them. You speak of having found *C. laciniosa* at Natchitoches but I don't find either nuts or leaves in the package.

I feel helplessly confused about the southern Pignut Group. The more material I see the worse the confusion becomes.

You certainly did not send the specimen of the Oak which you took for *Q. breviloba*.

I think you had best send me a specimen of your arborescent Alder from Selma that I may feel sure of the species. When are you going to send me the lists of trees from your Alabama place? Such a list certainly should be published.

P.S. — Please send us some of your printed labels for these last specimens.

49

November 26, 1913.

I have your note of November 21st and the nuts, for which many thanks. We had to use some of your labels with the nuts and I wish you would send me about fifty of your blank labels for future use. I will write you in a day or two about the Selma Apples and Hickories.

My correspondent in Natchez, who is not a botanist,[4] has found there what I feel quite sure is *Carya texana* which is called Pignut. My correspondent writes, — "One who travels in the adjacent Louisiana country tells me that the Bitter Pecan or Pignut is thick in the swamps and that representatives of German dealers have taken the output of the sawmills for use in the making of carriages. The wood is said to be very tenacious." This may be *Carya texana* and it would be interesting if you could get into touch with some one in that part of the state and find out about it. She also writes, — "I hear of a nut somewhat larger, thin-shelled and very sweet in the West Feliciana Parish."

[4] Miss C. C. COMPTON.

You once told me that you had heard of a flat Pecan somewhere near Baton Rouge and it is possible that this may also be *texana* which is evidently much more widely distributed than we had supposed. If it grows in Natchez there is no reason why it should not be in West Feliciana.

50

November 28, 1913.

In regard to your Alabama *Malus* Nos. 1 and 2 appear to be the same and look very much like *M. ioensis*, var. *Palmeri*. Before we can be absolutely sure of this, however, we should see the flowers. No. 3 is most like *M. fragrans*, I think must be a new species; certainly judging by the leaves it is a very distinct form.

51

December 3, 1913.

I am glad to get your letter of November 27th and to hear that the plants arrived safely.

Although I wrote both to the Superintendent of the Park and to the Chairman of the Park Commission I have never heard a word from either of them. They seem to have curious ways in your town. I understand from your letter that the express bill has been settled by the Park people and I will interview our expressman on the subject. I do not think the plants which you said you sent on "Monday" have yet turned up.

52

December 6, 1913.

I have your package of plants. The *Hibiscus* from New Orleans is *H. mutabilis* from southern China. The Oak from Natchitoches, called by you *Quercus brevifolia*, is *Quercus stellata Margaretta*. The *Ilex Amelanchier* is all right. This is the first time we have ever had any wild specimen of this plant, having known it only from a plant in cultivation. This we have lost and we very much want to get it again either by seeds or roots. Possibly this can be managed next year. We shall be glad, of course, to get flowering specimens. Can you make Harbison understand just where it grows?

The *Viburnum* from Natchitoches is *V. scabrellum*. Your *Vacciniums* Nos. 1, 2, 3 and 5 are *V. Elliottii*. No. 7 is *V. stamineum* or one of the allied species; and Nos. 4 and 6 are *virgatum* which has not before been in our herbarium from Louisiana.

Rosa humilis is all right. The *Rubus* from Winnfield is, so far as we know, an undescribed species. We collected the same thing at Washington.

In regard to your three *Acers* from Natchitoches No. 1 is *floridanum*. No. 2 *leucoderme* var., certainly a very curious looking form, and No. 3 *leucoderme* like the typical plant.

I think this will account for all your specimens. I hope you will soon send us another supply.

53

December 20, 1913.

Your last package of plants has arrived. In regard to *Rubus*, Nos. 2, 4 and 7 are *R. trivialis*; the others all seem to be the common Highbush Blackberry which we have collected together. It is nearest *R. Andrewsianus*, at least it should be referred to that species until the southern Blackberries are more critically studied than they have been.

I find that the older name for *Zizyphus vulgaris* is *Z. sativa* Gaertner.

54

February 24, 1914.

Your *Cornuses* have arrived and seem to be correctly named, except what you call *C. sericea* is *C. obliqua* or *Purpusi*, the western and apparently the southern form of *C. amomum*, the correct name for *C. sericea*. We have had no specimen of this form so far south and I am glad to have it.

In regard to the Sassafras business, Fernald in the January 1913 number of Rhodora has taken up a White Sassafras, first distinguished by Nuttall under the name of *S. variifolium* var. *albidum*. This variety is distinguished by its glabrous branchlets and leaves which are glabrous when young. According to Fernald, it grows from western Massachusetts to the Carolina mountains. According to Nuttall, the inhabitants of the Carolinas distinguish the two forms by the names of the White and Red Sassafras, the root of the White Sassafras being much more strongly camphorated than the ordinary sort and nearly white. No one says anything about the wood of this variety but if the roots are white the wood might be. I think it would be well to look at Sassafras in Louisiana and see if you can find it with glabrous branchlets and leaves. By the way, we have no specimen of Sassafras from Louisiana.

I am sorry about the flowers of *Acer Drummondii*. Have you no specimens that you can spare us? Does not *Acer Negundo* grow in eastern Louisiana? I have it from the state only from Shreveport and Opelousas? I should like to see the eastern Louisiana specimens. There are no specimens either from Mississippi or Alabama here.

55

February 26, 1914.

I have been looking over the Louisiana Hickories and I do not get very much comfort from them but send you the following notes:

Opelousas, East. #5: this is the tree with close smooth bark but with the buds, fruit and foliage of the Shagbark, *C. ovata*. This is the most interesting perhaps of the Louisiana Hickories, for if it is a species or even a variety it changes all our ideas about the Shagbark Group of the genus. If we should consider it a hybrid what would be its parentage? We saw but one tree and it is most desirable to locate others in that Group and try

to get flowering specimens and young leaves this spring. 1 and 3; on the bank of the bayou. We thought these were the same, but notice that the rachis and midribs of the young leaves of #1 are very pubescent, and that of #3 are perfectly glabrous. #4 appears to be the same as #3. #3 and #4 have very large buds and I cannot place them, or #1 either, although #1 may possibly be a tree which is common on Mobile Bay.

Opelousas, West. #1 and 2, the two trees standing near each other in an open wood not far from the swamp which you crossed in the spring to find the large tree of *Crataegus brachyacantha*. #1 has pear-shaped and #2 subglobose fruit; they are probably the same and I believe an undescribed species or a form of the Winnfield Yard tree, distinguished by hairy branchlets and the yellow scales on the fruit. I have seen what seems to be the same thing from Florida and Georgia. It is very important to collect these two numbers in their spring condition that we may see if the young leaves are covered with yellow scales like those of the Winnfield yard tree. #4, "rich woods west of Opelousas; close pale bark; young leaves fragrant and red like the Lake Charles tree." This we did not relocate in the autumn.

Winnfield. The yard tree; this so far as I can tell now is an undescribed species. We have sufficient material. Like so many other species it has both globose and pear-shaped fruit, for I take for granted that the trees in the yard are of one species. #2, "tall tree in woods". This may be the same as the yard tree but I am not sure. The leaves look all right but I can find little trace on the buds of the yellow scales which are so conspicuous on those of the yard tree. The fruit of #2 is depressed-globose. I should like to see the young leaves of this tree. I do not remember where it is. Was it at the last place we went to in the afternoon, in open ground on a slope north (?) of the town where we found also a large Plum tree? On April 6th at Winnfield, "in dry woods", we collected a specimen with young leaves white tomentose on the lower surface and only sparingly pubescent above. The branchlets are red, slender and glabrous. This I suppose is one of the trees in the low ground before we got to the quarry. In the autumn we collected in this region *C[arya] alba* but the tree we collected from in the spring is not *C. alba*. What is it? We missed it in the autumn.

Munroe. In dry woods near Munroe we collected specimens of *C. alba* and of a tree of the Pignut Group with very slender pubescent branchlets and small buds; leaves with broad leaflets and pubescent petioles and rachis. Old nuts from the ground of what was probably this tree are very small. This appears to be a common tree in dry woods near Munroe. I do not know it.

Bernice #2. Only young leaves and flower-buds. Can this be the same as the yard tree at Winnfield? The region for it would, of course, be all right. It ought to be looked up.

West Feliciana. #1 looks like *C[arya] porcina*. The buds are much larger than those of the northern tree. #2, no nuts. Can this be the Winnfield yard tree? #3, *C. ovata*, no nuts. #4; the nuts look like those

of *C. megacarpa*. I find no foliage of this. #6, *C. porcina*? #7 and 8: I do not know if these may not be the same as the Munroe Pignut. They are pubescent like that tree, but the nuts are much larger than the old ones we picked up from the ground.

Bayou Lacombe. I can say nothing about two very fragmentary specimens, Nos. 1766 and 1785.

Lake Charles. I think that we have to begin all over again. You turned to the right at the river after passing Irish Bayou and I to the left. Along the river I found trees with bright red, fragrant leaves on April 2d, and pale close bark. Is it possible to say if the tree you collected from is the same? This Lake Charles tree must be undescribed. I believe the same thing is west of Opelousas.

Lucknow.[5] Of the tree with small, rather thick-shelled pear-shaped fruit which I have sent to you I have not seen foliage and know nothing about it.

Natchitoches. #1 and 2. I have no idea what these are. #5 seems to be a pear-shaped *C. alba* with rather small buds. #6 looks like *C. pallida*, but it is the only station west of Selma I know for it and it should occur at intermediate stations. Does this tree have pale bark and does it grow in low ground or on high ridges? I should like to see young leaves. #7, *C. ovalis* with small fruit. #10: I think this is a new species which grows also at Fulton, Arkansas. Young leaves and flowers are important as well as notes on size, habitat, etc. #xi, a pear-shaped *ovata*! What is the bark like. #3, Grandcone.[6] The fruit looks like that of one of the forms of *C. ovalis* but the buds are covered with yellow scales. Unless it is another *C. pallida* it is too much for me. Natchitoches seems to be the storm centre for everything that ought and ought not to grow in Louisiana.

I do not want to describe any new species or varieties of *Carya* until next winter, so that we may have the benefit of another season's field work. It is important that the trees of Lake Charles, east and west of Opelousas, Lucknow, Bernice and West Feliciana, should be visited this spring. Winnfield is less important and there is still much to be done there. If you are able to get good spring material it may be desirable for me to go to Louisiana again in the autumn and take another look at some of these trees, for I feel that we are not going to get any right conception of them except by constant field observation. West of Opelousas there is the new apple (#2) of which flowers are needed, and it would be well to get apples from Crowley as your correspondent seems to have given out.

I expect to go to southern Florida this spring, leaving here on the 16th of March, and to stop in Georgia and South Carolina probably on my way north. You may think that Louisiana Hickories are bad, but I am inclined to think that those in south-western Missouri and in the southeastern states are even more troublesome.

Let me hear what the prospects are of your being able to do a good deal of field work this spring. Harbison is to go to Selma for your Plum flowers

[5] Sw. of Rayville, Richland Parish.

[6] Error in original letter for Grand Ecore?

as soon as he hears from a friend there that the season is opened. I hope you do not feel that we know anything yet about the Louisiana Plums.

56

April 16, 1914.

I am back from the south where, although the spring was very backward and the weather rather cold, I saw much to interest me and was able to extend southward the range of a number of trees. Just before I left I had a note from you saying you were sending me flowers of *Acer Drummondii*, but the package has not yet arrived. I suppose it will turn up in time.

I am inclined to think you are right in supposing there are two quite distinct *Lindens* in Louisiana, one quite glabrous and the other covered on the lower surface of the leaves with stellate pubescence. The former is well represented at Lake Charles; the latter we found at Winnfield and Opelousas, and you found it at Natchitoches. This appears to be the common species of eastern and southern Texas, except on the coast where *Tilia pubescens* occurs. It is desirable to get flowers of the pubescent form from Natchitoches or some other convenient station.

I am more than ever convinced how little we really know about our southern trees and how much there is still to do. I think I found on the Caloos[a]hatchee River in Florida what must be a new Water Hickory or, if not a species, a very distinct variety. I see Small credits Louisiana with *Cyrilla parvifolia* but we have no specimens from the state in our herbarium.

I am anxious to hear what success you have had with the Hickories this spring.

57

May 20, 1914.

I have taken a look at your Hickory specimens. No. 6 at Natchitoches, if the flowers and fruit are from the same tree, is something I do not know at all. It has slender branchlets and small buds of a Pignut but the young leaves are as pubescent as those of *C[arya] alba*. The nut is very much compressed and the husk splits readily. If there are many trees like this, I do not see why it is not a new species.

No. 10, Natchitoches. Is there not a mixture here? The flowering specimen is *C. alba* but the fruiting specimen is one of the Pignut group.

There appear to be no flowers of xi. Natchitoches and 3 Grand Ecore, and no fruiting specimens of 12, 15 and 16 Natchitoches and 20 Grand Ecore. Note that 12 Natchitoches and 20 Grand Ecore have the yellow scales on the young leaves of the yard tree at Winnfield and of the trees with the round and pear-shaped nuts of West Opelousas. I should suppose there was something in the scales of the young leaves of specific value which may help us.

East of Opelousas B. 9, 13, 14 and xi. seem to be new numbers of which there are no fruiting specimens.

West Feliciana 10 and 13 are, I suppose, new numbers but we have no fruit to match them. I believe that the round and pear-shaped fruits of 1 and 2, West Opelousas, belong to one species and that there is no character in the shape of the fruit in Hickories.

I hope you are well and not too hot.

58

June 17, 1914.

I have read with much interest your Notes on the Flora of Louisiana, No. 1,[7] but why not follow the rules of the Vienna Congress, as you do in some cases, and call *Quercus acuminata Q. Muehlenbergii* and *Magnolia foetida M. grandiflora*? Also why not write "*canadensis*" in *Cercis canadensis* with a lower case *c* when you write *caroliniensis* with one?

I do not seem to remember *Pinus glabra* from West Feliciana. Did I have a specimen from there? Of course I know it is in Covington and in Jackson, Mississippi.

I am looking a little into *Tilias* and I find two specimens of yours which I think with our present lights will have to be called *T. americana*. One was collected at Alexandria in June 1905 and the other at Wakefield, West Feliciana, June 1907. Unfortunately neither specimen is numbered. Do you suppose it would be possible to locate these trees? You once insisted that the St. Charles *Tilia* was different from the one at Natchitoches. There are certainly two species at Lake Charles, one like the Natchitoches and Shreveport tree with very thin leaves with scurfy pubescence on the lower surface which soon rubs off or on some individuals is persistent, and the other which is entirely glabrous. The former is *T. leptophylla*; the latter seems undescribed. You collected this last in flower May 12, 1911, but not in fruit. We have, however, a poor fruit specimen collected by Andrew Allison in the vicinity of Lake Charles (No. 322, no date) which came to us from the National Museum at Washington. Do you remember the tree from which you collected the flowers and can you locate it? We collected on March 26, 1911, *Tilia leptophylla* at Lake Charles and no doubt you were looking for our tree when you made a specimen on May 12th of that year. This May 12th tree should certainly be looked up and investigated further. *Tilia leptophylla* appears to be the species of Opelousas and Winnfield, and I presume is the common Louisiana Linden.

There is a *Tilia* collected at Selma by Harbison with large leaves oblique at the base and covered below with silvery white tomentum, which occurs also on the petioles and peduncles, and the young branchlets are stellate-pubescent. I do not think that this can be *T. heterophylla*. The specimens were collected May 5th in young bud. This tree should be investigated and collected. Is it too late for the flowers now? Fruit, of course, is also needed. Judging by Harbison's material, this tree can hardly be referred to any of the described species. It is evident that there are several more Tilias in the southern states than were formerly recognized. I am working on Hickories and am going to write you about them very soon.

[7] Published in Plant World 17: 186–191. 1914.

If your wife has been in Washington I presume she has entirely recovered. I certainly hope so. I hope you are going to have a good summer in Alabama. I am going over to England for a few weeks on the 9th of July but shall be back in time for the south in the autumn.

59

June 24, 1914.

I have yours of the 20th and the specimens. The Linden from Selma looks like *Tilia americana*. I suppose for the present, at least, it will have to be so-called. Your specimen from Avery Island is not like either of the Lake Charles species, and if it is common west of the Mississippi River I have not seen it there before. I have seen specimens of what I believe to be the same thing from River Junction, Florida. I hope you will gather and press a number of specimens with flowers or young fruit of *Tilia* which you say is common on your place, for we have by no means got to the bottom of this Linden business yet.

Your *Amelanchier* looks most like *A. sanguinea* which is a northern species. You better send me specimens of your *Azaleas* or anything else interesting.

Can you not arrange to stop here on your way south from Maine? I expect to be back on the 25th of August and it will be a great pleasure to see you and your wife here, and it would give us an opportunity to talk over many things about the autumn campaign. I suppose you could stop in Boston as well on the way south as on the way north.

I hope I shall hear from you again before I leave on the 8th of July.

60

June 29, 1914.

Many thanks for yours of the 24th with the Lindens. No. 2 certainly looks like [*Tilia*] *leptophylla*, and No. 3 like Harbison's plant. This seems to me the same as your Avery Island species. If I am right in this it makes its distribution from western Louisiana to western Florida. The general outline of the leaf looks like that of *heterophylla*, but the tomentum on the lower surface is less dense, and this new tree has more or less pubescent branchlets, peduncles, pedicels, etc. The range, too, is quite different and I do not see why it is not a good species. I hope you will keep watch of it.

I want to describe as new a Hickory from Starkville, Mississippi, a large tree with dark rough bark and ovate fruit with a husk of medium thickness, and a slightly angled nut. The Starkville tree is peculiar in the *ovalis* group, to which it belongs, in the tomentum on the lower surface of the young leaflets, and in the dark rough, not scaly, bark. Your No. 10 of Natchitoches, although I have no young foliage, can probably be referred to this species. Do you remember anything about it?

I do not remember if I told you that I think we must call the Winnfield yard tree and 1 and 2 from West Opelousas *C. arkansana*. They all vary among themselves and from the type, but unless we are going to make a

species of practically every Hickory tree a good deal of allowance has got to be made for variation.

I hope you are keeping a sharp lookout for Selma Hickories for I feel practically as much in the dark about the southern species as I did two years ago.

61

July 7, 1914.

I have yours of the 2d and the package of Lindens. The perfectly glabrous and very coarsely toothed leaves are those of what we have considered *Tilia americana*. I think it can be so considered until we find out something to the contrary. The species which you have not sent before with leaves brownish below and covered with very fine pubescence is *Tilia Michauxii*, and the white-leaved species is certainly the same as that from Avery Island and River Junction, Florida. I have n't seen this tree from any part of Louisiana but Avery Island.

I expect to be back here on the 24th of August, and if by any chance your return has been delayed please let me find a letter from you then telling me where you are and what your plans are.

62

November 6, 1914.

We got home safely a couple of weeks ago and saw more Hickories in Texas and in Arkansas than we did in Louisiana this time. About the Louisiana species I shall write you later.

I have arranged to send Palmer to Natchitoches early next spring and to let him make his headquarters there through the season, or long enough to solve the botanical problems of that mysterious place. I think we can depend on him to make a good collection.

I wish you would send me a specimen of the arborescent form of *Rhus glabra* either from Alabama or Louisiana. I should like, too, Louisiana specimens of the variety of *Taxodium* which you first reported from the state. The further west the specimen comes from the better. I should also like to have for purposes of future reference a specimen of *Pinus glabra* from Bayou Sara, as this so far as I know is the extreme western station reported for this species.

We are having wonderful weather here but it is still dry. Do not work too hard over your class. Real botany is much more important.

63

November 25, 1914.

Many thanks for the western specimens of *Prunus*. I hope to live long enough to get these things straightened out but the prospect at present does not seem to me very good. It is a tough proposition.

It is not surprising that *Carya texana* should be found near Shreveport. I believe it is a very widely distributed tree.

I am very sorry to hear about the losses in your family. It is an awful business altogether and I am afraid the end is still far distant.

64

December 21, 1914.

I am taking another look at your *Prunuses* from Alabama and Louisiana and report as follows:

Sardis 1 and 3, *P. angustifolia*, the latter with unusually broad leaves, but I suppose it is a vigorous shoot.

Umbellata, 2, 4, 5, 8, and 11 from River Road.

VI., *munsoniana*.

15 and 16, leaves only, may be the same.

VII., the new Cherry, no flowers and the tree destroyed.

9, evidently the Big Tree Plum.

Natchitoches 1, *munsoniana*.

Natchitoches 6 and 7, only flowers.

Natchitoches 3, 4 and 5, *P. tarda*.

Shreveport 17 and 20, *P. tarda*.

Ruston 2, fruit but no leaves.

10, *munsoniana*.

4 may be *P. americana*. This number is worth looking up.

9 may be a small-leaved Big Tree but there are no flowers or fruit.

The common Plum of Louisiana is what we have called for the present the Big Tree Plum. I refer the following numbers to it: 20, 21, West Feliciana, 1, the Butler place. 4, Laurel Hill. Ventree's Plantation, April 27, 1910. Laurel Hill, ii., iii. 1, open woods, Hammond. ? Butler place. 2, Covington, March 28, 1911. Natchitoches, 11. Ruston, 6 and 8. Ventree's plantation, i., ii. Pineville, September 20, 1912. Archibald, 18. Shreveport, k., iii. Alta, 93, 14. Clear Lake, 1. Mhoon Plantation, i., ii. This is a common tree from Missouri to San Antonio, Texas, and, judging from your #9 from Sardis, extends into Alabama, although this is the only Alabama specimen I have seen. It appears to vary greatly in the size of the fruit, in the time of flowering, and in the time of the ripening of the fruit. I tried to make two or three species of it but I am afraid they are not very good, with the exception perhaps of *P. reticulata* which has distinctly thicker leaves, smaller flowers and very late-ripening fruit. It ought to be possible to find some characters in the bark, and #2 from the Butler place may be distinct.

I do not think the color of the fruit makes much difference in Plums as most of the species have red and yellow fruits. *Prunus munsoniana* is probably only introduced into Louisiana and Alabama as it is a more western species which has been cultivated for a great many years and is beginning to establish itself in many different parts of the country.

I am still in doubt about the right name for the Big Tree Plum. It may be the *Prunus mexicana* of Watson, based on a very poor specimen of northeastern Mexico, or it may be that my *Prunus arkansana* is the name for it.

It is unfortunate that the red-fruited Plum which Bartram found on one of the islands off the Louisiana coast has disappeared.[8] This was described by Rafinesque as *P. coccinea* which, if it is the Big Tree Plum, would be the oldest name. It may, of course, have been a red-fruited form of *Prunus umbellata* which appears to be common in the east Gulf States.

With the compliments of the season and all good wishes for the New Year, I am,

65

January 1, 1914 [1915!]

I can report about your West Feliciana Hickories as follows:

2, 3, 6, 10, 13 and 20 I refer to *Carya megacarpa* Sargent, although of #3 we have no fruit. Next to *Carya alba* this is the commonest coast Hickory from South Carolina to Louisiana, extending into western Mississippi and probably into western Louisiana. It appears to run into *C. porcina* and I am now thinking of making both, that is *porcina* and *megacarpa*, forms of *C. ovalis*.

West Feliciana #1, April and October 1914, which is very pubescent, is either another species, or, judging by the nuts, a variety of *megacarpa*. Notice that #1, April 20, 1913, is perfectly glabrous. I have n't kept this specimen.

#7 and 8 are the pubescent tree like #1 of 1914. 1785 of 1908 is evidently the same, but as there is no fruit I have not kept it.

1766 of 1907 is evidently *megacarpa*. I have n't kept this.

I believe that *C. arkansana* or *C. texana* get into Louisiana at Natchitoches but I am not ready to say much yet about the western Louisiana Hickories.

I hope that you are well and that 1915 is going to treat us all better than 1914 has, although present appearances for the happiness and prosperity of the world do not seem particularly good.

P.S. — I suspect that numbers 3, 4, 9, 13 and 14 of East Opelousas are the same as #1 of West Feliciana.

66

January 7, 1915.

I have yours of the 14th. Am very sorry to hear about the grippe.

Prunus is very difficult, especially when one does not see the plants growing. I have no doubt from what you tell me that your 1 and 3 of Sardis must be separated from *angustifolia*, for the time of the ripening of the fruit certainly ought to have some specific significance. I will look at the specimens again.

It is my plan to let Mr. Palmer, who is collecting for the Missouri Botanical Garden and the Arboretum, make his headquarters at Natchitoches

[8] *Travels* 423. 1791. Francis Harper (Naturalist's ed. *Travels* 598. 1958) suggests *Prunus hortulana* Bailey. Rafinesque (*Fl. Ludoviciana* 435. 1817) quotes Bartram almost word for word, even to the "subulated point" of the leaf!

this year in the hope that he will be able to make a pretty complete collection of the flora of that region. As he can reach Shreveport easily from Natchitoches I understand it ought to be a good place of operations for work about Shreveport and eastern Texas. I think if he can make a good collection in that part of the state it ought to simplify work for us in the other parishes. I wish you would tell me how early you think he ought to get to Natchitoches to get the earliest things, which I suppose will be *Prunus* and perhaps *Salix*. I should like to have him there early enough to get all the Plums as they come into flower.

67

January 11, 1915.

Thanks for your letter received on Saturday. I went to look at those Plums again before finally deciding about *reticulata*, *arkansana*, etc. The type of *P. mexicana* is in the Gray Herbarium; it is a miserable scrap. The leaves look a good deal like what I call *arkansana*.

Carya #1 from Lake Charles, the tree with stellate pubescent petioles and rachis, young leaves very red and fragrant, growing in low wet ground. The branchlets are glabrous but pubescent in your specimen of October 1913. Is this the same? Flowers have never been collected and are needed. Your specimen from Lake Charles, October 1913, is probably this #1. I do not know anything like this but we ought to find it in other places if it is a species, for Hickories are generally pretty widely distributed. We ought to see more of this tree. My only other Lake Charles specimen from you is #2, September 1914. I have also two unnumbered specimens of fruit collected at Lake Charles by you in 1913; they are both pear-shaped and one is much larger than the other. Do you know to what they belong?

#4, east of Opelousas, with red and fragrant young leaves, may be this #1 of Lake Charles but the pubescence is quite different. The fruit is pear-shaped but then the shape of the fruit does not count for much apparently. Is n't #5 from Natchitoches the same as #1 from Lake Charles?

#1 of East Opelousas, the tree with globose fruit, between the road and bayou and close to the road, may represent a new species. I do not find flowers and young leaves of this. Did you ever collect them?

This is only a slight dose of what I will give you soon on the Hickory situation. If you think the trees in one state are difficult, how about the whole country? It is a tough proposition but I hope we are making a little headway.

68

January 14, 1915.

I have had to give up the idea of our #5 of East Opelousas as a form of *C. ovata* with smooth bark. The nut is reddish, not white, and not sufficiently angled for *ovata*. The leaflets are constantly seven, while it is rare

to find seven leaflets in *C. ovata* and of a different shape; and the branchlets are too slender. I understand that your numbers 9, 13 and 14 from the same region are trees with smooth pale bark.

5 and 9 from Natchitoches which you think the same as 5 from Opelousas I believe are *C. megacarpa*, although the leaves are somewhat pubescent. The fruit of these numbers is distinctly pear-shaped and shows the yellow scales of *megacarpa*. I hope that in these scales we have found a good specific character. I have drawn up a description of Opelousas #5, for which I shall propose the name of *C. leiodermis*. I do not see why it has not got to go into a new group but I want to know more of this tree.

#2 of Natchitoches seems like a tree which is growing at Starkville, Mississippi, which I am calling *megacarpa stellipila*. The fruit of your specimen is smaller but the pubescence on the young leaves is the same, and your plant is certainly some kind of a *megacarpa*.

#1, Natchitoches, *C. megacarpa*.

#7, Natchitoches, *C. ovata*.

#13, Natchitoches, *C. megacarpa*.

#10, Natchitoches, the leaf specimen is *C. alba*, but the fruit under this number seems to be *C. megacarpa*.

#1, West Feliciana, seems the same as #2 Natchitoches, that is var. *stellipila*.

#7, West Feliciana, *C. megacarpa*.

#8, West Feliciana, seems the same as 1, West Feliciana.

#4, West Feliciana, of which there is no leaf specimen, is probably a *megacarpa*. Have you leaves of this? If #4 is *megacarpa*, this leaves none of the West Feliciana numbers unaccounted for, but there are still many problems west of the Mississippi.

69

January 20, 1915.

I feel sure that there is some mixture in Natchitoches #6. The flowering specimen seems to be *Carya alba*, while the mature leaves and fruit under this number belong to an entirely different group. I do not suppose you remember anything about this.

70

January 22, 1915.

Have you any evidence that *Carya cordiformis* grows anywhere on the Louisiana coast? I have specimens from West Feliciana and from the neighborhood of Opelousas. I have nothing from Lake Charles or the Covington region.

71

January 27, 1915.

I have yours of the 22d. I have about finished now all I can do on Hickories until I get more information and then shall take up the Lindens. about which I will write you later.

I should not think there would be any necessity for your going to Natchitoches again if Palmer does his work as well as I hope he will, and in a week or so I will make suggestions for spring work. I very much hope to get to Louisiana myself again this spring for a few days but I do not know if I can manage it. If I do, of course we must meet somewhere.

I am sorry to hear that you are likely to find new Plums in Louisiana, the worst proposition that there is.

72

January 29, 1915.

I have yours of the 26th and write to say that I shall be very glad to have a specimen of *C[arya] cordiformis* from the Lake Charles region as it apparently is not a common coast tree.

I have placed the Winnfield yard tree and 1 and 2 from West Opelousas with *C. arkansana*. The Winnfield tree may be all right but I am not very well satisfied with 1 and 2. *C. arkansana* usually grows in high dry ground and has dark deeply furrowed bark. These Opelousas trees were in low ground and had pale bark. I do not know what else to do with them unless to make a new species of them, and I do not like to do this until we can find more individuals. This is a thing still to attend to.

73

February 6, 1915.

I have been through the Louisiana specimens of *Crataegus* again and I do not think that the situation is entirely hopeless. The trouble is that the plants of which we have insufficient material are pretty widely scattered, making it difficult to get what is necessary for their determination. Palmer will look after Natchitoches and I suppose can get to Shreveport where there are still a number of species we do not know.

I have placed *Crus-galli* #3 from West Opelousas with *C. tersa* of Beadle which we found in the same locality, and your *Crataegus* 39 from Natchitoches with *C. edura* Beadle.

In 1901 I collected at Shreveport a *Viridis* species which I now think is *C. velutina* Sarg., the type of which grows on the Red River at Fulton; and Bush has apparently collected it at Natchitoches "by iron bridge." This is a new species for Louisiana. I collected at Shreveport another *Viridis* species with villose corymbs, color of the anthers not given and no fruit. It was in bloom on April 20th and seems distinct. And also on the same date another *Viridis* species with very broad, ovate leaves which had been out of bloom, I should suppose, for two weeks. These two appear to be undescribed species.

At Munroe in 1901 I collected sterile branches of a shrub two to three feet tall with three-lobed leaves on the young shoots. It looks like a *Viridis* species. What is it?

From you I have #16 & 23, a *Viridis* species collected June 1908 at Richlands, with half-grown fruit only. Do you know anything of these?

Natchitoches *Crus-galli* species. You do not give the color of the anthers of xii., xiii., xvi. and xvii. Can you?

Minden. I have several fragmentary *Crus-galli* specimens from Minden, collected by me in April 1901 and by Bush in August of that year. I believe you have never been there. In August Bush collected there "on right hand side of road to prairie west of town, just before getting to spring," a *Viridis* species "with bark and branches rough, dark, scaly and flaky, exactly as in *C. aestivalis* which is beside it." This sounds like the *Viridis* species we saw at Munroe growing with *C. aestivalis*. The specimens look alike. Flowers are much needed.

Pineville. I collected on April 3, 1885, in bud a *Crus-galli* specimen with small, broadly obovate leaves pale and glabrous below and villose few-flowered corymbs, no spines and red branches. Is it not time that this specimen should be cleared up?

You do not give the color of the anthers of your #19 Pineville, April 24, no year.

No number and no fruit from a *Crus-galli* specimen collected by you out of bloom April 5, 1912. This must have flowered very early for a *Crus-galli* species.

I collected in 1901 at Shreveport a very narrow-leaved and distinct *Crus-galli*, twenty stamens, color of the anthers not given.

All the undetermined and undescribed Louisiana species belong to the *Crus-galli* or *Viridis* groups and there are not many of them. The only exception is the plant from Holtonville which had pretty well grown fruit on March 20, 1911, and is therefore a very early flowered species. It may be a *pruinosa* but I am not sure. If it is, it is the earliest flowered of the whole group and hundreds of miles from any other species of the group. This certainly ought to be investigated this year.

Munroe, where there are also *Crataeguses* to investigate, Minden and Pineville seem to me to be the *Crataegus* regions for you to visit this spring if you can manage it. At Munroe there are Hickories to look for and these I will write you about soon. These three places are not very far apart and might, I should think, be conveniently taken in on one trip.

I hope to be able to meet you at Lake Charles, or some other convenient place, about the middle of April.

74

February 19, 1915.

I believe now that we have the Hickories from east of the Mississippi pretty well in hand with the exception of one or two Alabama and Mississippi species or varieties, but there is still a bad lot of them in western Louisiana, southern Arkansas and Texas. I cannot believe now that 1 and 2 of western Louisiana can be referred to *C. arkansana*, variable as that species appears to be. The bark and place of growth won't do. Notice the prominent tufts of white hairs on the margins of the leaves of #2 collected by you in April. These are absent from the young leaves of the Winnfield yard tree which seems to be a good *arkansana*. It is important

to find more of these West Opelousas trees and to learn something about them. Can you undertake this?

#4 of East Opelousas seems the same as West Feliciana 1 and 8, *megacarpa stellipila*.

#1 of East Opelousas I am making a new variety of *C. ovalis*, var. *subglobosa*, distinguished by its large fruit and by the stellate hairs on the rachis and midribs of the leaves. I am sorry we have no winter-buds of this.

#3 of East Opelousas is a pretty good *megacarpa* and I am so considering it. The buds, however, are very large.

This seems to clear up East Opelousas, at least for the present. One new species and a new variety from there are pretty good I think.

One of the interesting things to follow up is the tree "in dry woods" at Winnfield (I suppose this means near the quarry), with leaves hoary-tomentose below and slender branchlets. We thought when we collected it that it was some form of *alba* but of course it is not that. It is nearest *stellipila* but that so far as I know never has the dense hoary tomentum on the under surface of the leaflets. This is certainly an important tree to follow up.

I will write again on the Lake Charles and Munroe Hickories.

75

February 20, 1915.

I cannot make much out of the St. Charles'[9] *Caryas* partly because the specimens are not all properly numbered. This is my fault, however, at least very largely.

Your #1 of October 1913 is certainly a different species from your #1 of September 1914. The fruit #1 of October 1914 belongs, I judge, with the September specimen although it is marked 1 October. Why cannot this be the same as East Opelousas #1, *C. ovalis subglobosa*? Perhaps my specimen collected April 2d, 1913, by river, with bright red unfolding leaves may be the same, and I am not at all sure that your specimen without number, October 1913, may be the same as your #1 of that date. #1 of October 1913 has very pubescent branchlets and buds. I have two lots of Lake Charles pyriform fruit from you marked Lake Charles, English Bayou, and West Lake Charles. These are not numbered but perhaps you can tell me to which specimen they belong. I fear, however, that the whole Lake Charles situation is so mixed up that it can only be straightened out in the field.

On April 2, 1913, the Hickory leaves of Lake Charles were nearly fully grown. To be really useful they should be collected in an ordinary season by the middle of March I should think. Can you run over there for a day about that time and get very young leaves of all the Hickories and then meet me there about the middle of April? It seems to me that we should be there together.

[9] Surely a lapse for Lake Charles?

Carya from Bernice ii. April 9, 1913, is no doubt *C. arkansana*. I can tell nothing about the Munroe material which is too fragmentary. Possibly the tree in the field, the first one we collected from last autumn, is an *arkansana* but I am not sure. In these woods there is a small-fruited species with pale bark which I do not know at all.

If we meet at Lake Charles we might go to Munroe together and then I could get into Mississippi without going to New Orleans. Have you ever been to Delphi which is east of Munroe, and have you ever collected about Fort Hudson? I was there fifty-two years ago but of plants have no recollection except of the Magnolia which was very fine.

If such curious Hickories are found at Natchitoches, Lake Charles, Opelousas and Winnfield, why are there not others in other places in the state, and why is it not up to you to look out for them? I hope Palmer will pretty thoroughly cover Natchitoches and Shreveport and the regions between Shreveport and Texarkana, in Caddo Parish, where I believe that some of the Fulton, Arkansas, trees will be found. I believe you have not been in that corner of the state and I doubt if this has ever been visited by a botanist. So far as I now know the Hickories which need more investigation are 1 and 2 of West Opelousas, that is other stations where this tree should be found, the Lake Charles and Munroe species, and the tomentose Winnfield tree.

The situation is bad, but not as bad as it was. I hope you will be able to make the early visit to Lake Charles.

76

February 23, 1915.

I have yours of February 17th about the earliness of the season and am writing Palmer to advance the time of his arrival in Natchitoches.

I am surprised to find that there is no specimen in the herbarium here of *Castanea pumila* from Louisiana where it must be a common tree.

77

February 25, 1915.

Our large Opelousas *Malus* #2 seems to be the same as the Pineville tree which we have called *M. ioensis creniserrata*. It is certainly a very distinct looking form and perhaps when these things are better known than they are now would be considered a species. The trouble is that of these so-called species of *Malus* there seem to be many intermediates.

78

February 25, 1915.

We are still in doubt for want of material about the common *Malus* at Selma. Judging by the leaves, it is the same as *ioensis* var. *Palmeri*, which is the first species which we collected west of Opelousas, and west of the Mississippi appears to be a common tree.

I am afraid Harbison cannot get to Selma this spring. Is there any one

there who could send you the flowers? There might be some one there who would know enough to gather them fresh and send them to you for pressing.

79

February 26, 1915.

In writing you about *Castanea pumila* I overlooked the fact that we have a leaf specimen collected by you at Covington March 1911. The leaves are remarkably glabrous and very green on the under surface of that species. Sometime perhaps you will be able to get better material.

80

February 27, 1915.

I have this morning your letter of February 23rd about Lake Charles, etc.

I think now in Hickories that we can put a good deal of reliance on characters which have usually been passed over, like the scales on the unfolding leaves and on the winter-buds, therefore I think it desirable that we should get very young foliage of the Lake Charles Hickories this season if possible. That is why I suggested the middle of March but I daresay that would be too early. You can judge of that, however, in New Orleans much better than I can here. I should like very much to go there with you in April for I am particularly interested in those trees, and I think we ought to see them together.

I do not know if it is really necessary to go to Winnfield in the spring as we have material of that tomentose plant, but if we are in Alexandria and going to Munroe it would not be too much trouble to stop off there for a few hours if the trains are running conveniently. I should hate the idea of passing a night there.

The Hickory difficulties are narrowing down now unless some one is unfortunate enough to unearth a new lot of them.

81

April 23, 1915.

We got home safely last night direct from Selma via Montgomery. We had a couple of days in Selma and of course went out to your plantation. I do not think we saw many of the Plums because Harbison did not know apparently how to locate them. As he went about with you at Sardis he did not pay especial attention to exact localities. We saw your caretaker who was much pleased to know that I had seen you so recently and was very anxious for news of your wife. We did not get out to the bluffs on your place but went to Hatch's Bluff, which I suppose has about the same vegetation as yours. There does n't seem to be but one *Tilia* there which looked very much like No. 2 at Lake Charles, but on the other side of the river we found another species with leaves very silvery white and tomentose on the lower surface, and like one of the Florida and Georgia species.

What most interested me at Hatch's Bluff was a tree which looks like a Scarlet Oak but has fruit unlike that of any other Oak I have seen. If it is a Scarlet Oak it is certainly a very distinct variety and possibly it will have to be called another species. I will send you in a day or two a couple of the acorns and cups, and I especially invite your attention to the study of this tree. We only saw one specimen which was standing at the edge of the bluff about two or three hundred yards, I should think, from the point where we reached it across a plowed field close to a negro's house.

We saw the Oak which you called *Quercus Durandii*. It is certainly not the Texas tree of that name or one that grows near Columbus, Mississippi. I suppose, however, that it may be the *Quercus austrina* of Ash[e]. There was only one Plum in bloom and that was a good sized tree on the left-hand side of the road which leads past your place, which we reached by turning to the right at your gate. This tree was in the bottom, and in the bark looked a good deal like *Prunus americana*. I will send you in a few days a bit of my specimen, also the acorns of the peculiar Oak.

Another Plum which interested me was a very large tree with dark, slightly scaly bark, on the right-hand side of Marion Junction Road, just after the crossing of the second bridge on the Orville Road, one mile west of the city limits going out by the Orville Road. This is a large tree at the foot of a rather steep bank and is rather inclining towards the road; it is quite new to me. It was out of flower but I will send you a piece of the specimen. Perhaps you will be able to refer these two specimens to some of your numbers.

We found Mississippi and Alabama very hot, dry and dusty, and in our minds Lake Charles is still the pleasantest place we saw on this trip. I will write you again when I get things somewhat straightened out.

[*To be continued*]

SUSAN DELANO McKELVEY, 1883–1964

Richard A. Howard

In June of 1964, we received from Mrs. Susan Delano McKelvey a letter requesting her retirement from the Board of Overseers' Committee to Visit the Arnold Arboretum and from her appointment as Research Associate. Mrs. McKelvey stated she could no longer do the things she used to do and wished to make way for someone more active in both of the roles she cherished. Her wish was a difficult one to approve and so these notes were originally prepared in appreciation for service at a friend's retirement. We did not know that time was to be so short, for Mrs. McKelvey died on July the eleventh.

Susan Adams Delano McKelvey was born in Philadelphia, Pennsylvania, March 13, 1883. She was graduated from Bryn Mawr, married Charles W. McKelvey in 1907, and made her home for a number of years at Oyster Bay, Long Island. About 1920, she moved to Boston. Determined to study landscape gardening, she consulted Professor Charles Sprague Sargent at the Arnold Arboretum, volunteering her services in return for instruction in the identification of plant materials. Professor Sargent believed in testing volunteers, often with menial tasks such as pulling weeds or, in the case of Mrs. McKelvey, washing clay pots in the greenhouses. Under the guidance of William H. Judd, who was in charge of the greenhouses, Mrs. McKelvey also assisted in plant propagation; but she carefully reserved some time for reading, which led to research in the library. The famous lilac collection of the Arnold Arboretum was being developed, and, at Sargent's suggestion, she undertook the task of compiling information on these plants. The manuscript she submitted was of such value that E. H. Wilson added a brief history of the lilac and Alfred Rehder a key and a generic description. The horticultural information, the descriptions, and the documentation, however, were the patient effort of Mrs. McKelvey. The manuscript was published in 1928 as *The Lilac: A Monograph*. It was dedicated simply to "The Professor." This book, though long out of print, is still the only monograph of a favorite among flowering shrubs.

In the following years Mrs. McKelvey spent some time in the southwestern United States and became interested in the Yuccas and their relatives, often the most conspicuous plants of the drier areas. She sought help from various people in the identification of this difficult group and in the process learned at first hand how little information was available. At the suggestion of Dr. Alice Eastwood, of the California Academy of Sciences, she began a diligent study of these difficult plants, photographing and collecting specimens for the herbarium and for cytological

work. With Karl Sax, then a young cytologist, later to become director of the Arboretum, she published a paper basic to the understanding of the genus *Yucca* and its frequent associate *Agave*. In the study of the explorations that led to the discovery of the earlier published species of *Yucca*, Mrs. McKelvey became an authority on the routes of the early travellers and the explorers of the great Southwest, thereby unconsciously laying the foundation for still further research. The first part of her work on *Yucca* was published by the Arboretum in 1938. Its acceptance as a scientific study of high quality was soon evident, but the years of World War II delayed the issuance of part two until 1947.

The last of the three books written by Mrs. McKelvey was probably the most demanding of her abilities to extract historical, particularly botanical, data from general travel accounts. In 1955, the Arnold Arboretum published *The Botanical Exploration of the Trans-Mississippi West*, 1790–1850, by Susan Delano McKelvey. Although a volume of over eleven hundred pages, each seemingly with one or more footnotes of documentation, the book is an eminently readable account both of history and of geographical exploration from the botanical point of view. The reviews of this book which appeared in history journals, as well as in botanical ones, attest the value of the work with its interweaving of data from so many sources.

For her achievements Mrs. McKelvey was acknowledged and honored by horticultural societies and organizations. In 1929, she received the Centennial Gold Medal from the Massachusetts Horticultural Society and the Schaeffer Medal from the Pennsylvania Horticultural Society. In 1957, the New York Botanical Garden honored her with the Sarah Gildersleeve Fife award given to individuals for work in the field of botanical literature.

Mrs. McKelvey received her first appointment as a research assistant to the staff of the Arnold Arboretum in 1931, when Professor Oakes Ames was supervisor. It was the privilege of the succeeding directors to continue her appointment as a member of the research staff.

In 1928, Mrs. McKelvey accepted from the Board of Overseers of Harvard University an appointment to the Committee to Visit the Arnold Arboretum. Rarely did she miss a meeting or an opportunity to lend support and to express her interest in the work or the collections. She valued the living collections as plants to be enjoyed, as well as to be studied. She knew the value of herbarium specimens, and the difficulty of preparing them, and was appreciative of good herbarium management. Further, she realized the contributory value of cytological and anatomical work in her own monographic studies. Thus she fulfilled her duties on the Visiting Committee, interested and knowledgeable in the many aspects of a modern arboretum.

The association of Susan McKelvey with the Arnold Arboretum was a generous one. From her early efforts as a volunteer in the greenhouse to her bequest of research materials, her contributions were many. With her brother she devoted her energies toward raising a memorial fund to

Professor Sargent which remains a significant part of the endowment of the Arnold Arboretum. Through the years, her many gifts of letters and records, of specimens and photographs, of books and equipment, have all enriched our organization.

We regret the passing of a valued friend and supporter.

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* Prepared by Lazella Schwarten.

THE GENERA OF VITACEAE IN THE SOUTHEASTERN UNITED STATES [1]

GEORGE K. BRIZICKY

VITACEAE A. L. de Jussieu, Gen. Pl. 267. 1789, "Vites," nom. cons.
(GRAPE FAMILY)

Unarmed [rarely armed] woody, sometimes ± fleshy vines climbing by stem-tendrils opposite the leaves [or rarely tendrilless perennial herbs, shrubs, or small sometimes succulent trees]; branches often swollen [or articulated] at the 3–7-lacunar nodes. Leaves alternate [very rarely the upper ones opposite], usually 2-ranked, simple or palmately [rarely pedately] or pinnately compound, petioled [rarely sessile]; stipules small, deciduous [or wanting]. Inflorescences compound cymes, thyrses, or more rarely panicles, borne singly opposite the leaves and sometimes also terminal [rarely only terminal], sometimes provided with a tendril, usually manifestly peduncled, bracteate. Flowers small, regular, usually 4- or 5-merous (except the usually 2-carpellate gynoecium), hypogynous, pediceled, bi- and/or unisexual (at least functionally), the plants often polygamo-dioecious or -monoecious. Sepals connate, the calyx tube small, saucer- to cuplike. Petals distinct [very rarely connate at base] and spreading or recurved at anthesis, or apically coherent and dropping off as a "cup" at anthesis. Stamens opposite the petals, distinct [very rarely connate into a "staminal tube"], sterile [or very rarely wanting] in ♀ flowers; filaments filiform; anthers introrse [very rarely extrorse], dorsifixed above the base or near the middle, 2-locular at anthesis. Pollen medium sized or rarely small, usually 3-colp-(or)ate, oblate-spheroid to prolate, often rounded-triangular in polar view, reticulate. Nectariferous disc intrastaminal, rarely ± obscure [or wanting]. Gynoecium usually 2-carpellate [very rarely 3–8-carpellate],

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The author is indebted to Carroll E. Wood, Jr., for his many valuable suggestions; to Mrs. Julia Morton, of the Morton Collectanea, University of Miami, for fresh material of *Cissus* infected with fungus; and to Mrs. Gordon W. Dillon for her help in the preparation of the typescript. The figure was drawn by R. P. Monroe.

syncarpous, usually rudimentary in ♂ flowers; stigma usually small, simple [rarely lobed to parted]; style single, short to long; ovary superior, often variously adnate to disc from base to almost the top, 2[–8]-locular often incompletely so; ovules 2, collateral [rarely ovule solitary] in each locule, ascendent from carpellary margin at base of locule, anatropous, apotropous, 2-integumented, with a thick nucellus. Fruit a 1–4[–6]-seeded berry, usually ± fleshy and juicy. Seed coat usually hard, bony or crustaceous, with an adaxial raphe and abaxial chalaza; endosperm copious, hard-fleshy, rich in protein (aleurone grains) and oil, usually adaxially 3-lobed [rarely unlobed and/or ruminate]; embryo "spatulate," small, straight, ± axial; cotyledons small; radicle elongated, inferior. (Including Leeaceae Dumortier, Anal. Fam. Pl. 21, 27. 1829, nom. cons.) TYPE GENUS: *Vitis* L.

A primarily pantropical family of about 13 genera with some 700 species, a few genera primarily of the North Temperate Zone; four genera in our area.* The genus *Leea* L., of the Old World Tropics, which differs from the rest of the family mainly in its nonclimbing habit, sympetalous corolla, staminal tube, extrorse anthers, lack of a nectariferous disc, and ovary with 3–8 one-ovulate locules, is considered to represent either a subfamily of Vitaceae (Gilg) or a family of its own (Suessenguth, Schultze-Motel).

The genera of the very natural subfam. VITOIDEAE are distinguished primarily by a combination of relative length of style, structure of the nectariferous disc, and configuration of endosperm in cross-section. In some cases, the number of perianth parts and stamens, the character of the corolla (petals free and expanding, or apically connate and forming a "cup"), the inflorescence type, and rarely the character of the tendrils, also are considered to be of generic significance. Since most of the individual generic characters may vary considerably within and form transitions between the genera, generic limits are in some cases somewhat uncertain.

Although the vast majority of Vitaceae are sympodial, tendril-bearing vines, there are some tropical tendrilless species with the stems either monopodial or sympodial.[2] The occurrence of intermediates between in-

* After this article was in press, L. H. Shinners recorded (Sida 1: 384. 1964) a collection of *Cayratia japonica* (Thunb.) Gagnep. (*Rylander 167*, 8 July 1963 [SMU]), from a damp, deciduous-forested river bottom at the Delta Primate Research Center of Tulane University, Covington, St. Tammany Parish, Louisiana. This collection "possibly represents an escape from cultivation."

[2] The Braun-Eichler theory (Troll, pp. 30–32; Suessenguth, pp. 183–190) which regards the shoots of tendril-bearing members of Vitaceae as congenitally formed sympodia, seems at present to offer the most satisfactory explanation of the position of inflorescences and tendrils in this family. Of the other theories (see Eichler, Blüthendiagramme 2: 375–378. 1878; Suessenguth; Chadefaud), that of Nägeli & Schwendener (Das Mikroskop 605. 1867), based on a study of ontogeny, should be mentioned. According to this theory, supported recently by Shah (1962) on the same basis, the tendrils in Vitaceae are extra-axillary lateral branches of a monopodially branched shoot, destitute of subtending leaves. It seems appropriate to quote Troll's comments (*loc. cit.*) on Nägeli & Schwendener's theory. "Consequently, the ontogeny

florescences and tendrils (e.g., inflorescences sensitive to a contact stimulus and performing slight twining movements; those divided into a floriferous part and a tendril; or tendrils bearing a few flowers at the tips of their branches) is ample evidence for regarding the tendrils as modified inflorescences. The tendrils (and inflorescences) are either "continuous" (at each of 3–7 or more successive nodes) or "intermittent" (lacking on every third node) and are either monochasially 2–12-branched, or sometimes once or twice forked, or unbranched. The tendrils attach themselves to the support by twining (coiling) or by adhesive discs developing at the apices of their branches in response to a contact stimulus (e.g., in most of the species of *Parthenocissus*; the monotypic *Pterocissus* Urb. & Ekm.; and some species of *Cissus* and *Tetrastigma* (Miq.) Planch.).

Cross-pollination by insects seems to be the rule, although at least in some monoclinous or polygamo-monoecious species or varieties self-pollination (including geitonogamy) has also been recorded.

Floral anatomical data known for a few genera and species indicate incomplete septation of the ovary and "anatomically parietal" placentation (Kashyap, 1957; Nair & Mani).

Chromosome counts made for eight genera (about 57 species) are $2n = 22, 24, 26, 28, 30, 32, 38, 40, 44$, ca. 45, 48, 50, 52, 60, 72, 80, 96, 98, suggesting that both aneuploidy and polyploidy have been of importance in the evolutionary development of Vitaceae.

The very characteristic seeds of VITOIDEAE make possible the safe determination of fossils of this subfamily. The seeds are usually more or less oblong-obovate or obovate in outline (or sometimes pyriform and distinctly beaked at the micropylar region); the shape in cross section depends upon the number of seeds in a fruit. The seed coat is composed of a thin, outer, parenchymatous membrane and a hard, usually bony, inner layer (sclerotesta). The adaxial (ventral) surface of the sclerotesta exhibits a median cordlike to threadlike raphe, extending from the hilum to the seed apex and onto the convex abaxial (dorsal) side, where it joins a round to linear, depressed to somewhat elevated "chalazal knot." On the adaxial surface the raphe is flanked on either side by a deep groove (an infolding of the sclerotesta) varying in shape and length; the endosperm is consequently deeply three-lobed on the adaxial side. (See FIG. 1.)

The family is closely related to Rhamnaceae, from which it differs mainly in the predominance of sympodial vines, the hypogynous flowers, the predominantly two-ovulate locules, the apotropous ovules, the somewhat different pollen (similar to Araliaceae rather than to Rhamnaceae),

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leads to the improbable assumption of 'extra-axillary' branches destitute of subtending leaves, unless it happens that one is entirely willing to attribute the occurrence of such branches to a kind of dichotomous division of the [shoot] apex. By this [assumption of extra-axillary branches], one of the most universal principles of ramification [of the stems] of higher plants would be broken down ['through'] . . . This case impressively teaches what is generally true for congenital processes, that the understanding of these conditions can not be obtained from the ontogeny, [and] that, on the contrary, the latter itself requires explanation through comparison with the fully developed [mature] state." (Translation supplied.)

the type of fruit (berry), the usually lobed or ruminate endosperm, and the "spatulate" (*vs.* "investing") embryo. Together these families constitute the order Rhamnales.

It is noteworthy that species of *Tetrastigma*, and perhaps of some other genera of Vitaceae, are the exclusive host plants of the species of *Rafflesia* in Malesia.

Economically the family is most important for the species of *Vitis* (*q.v.*).

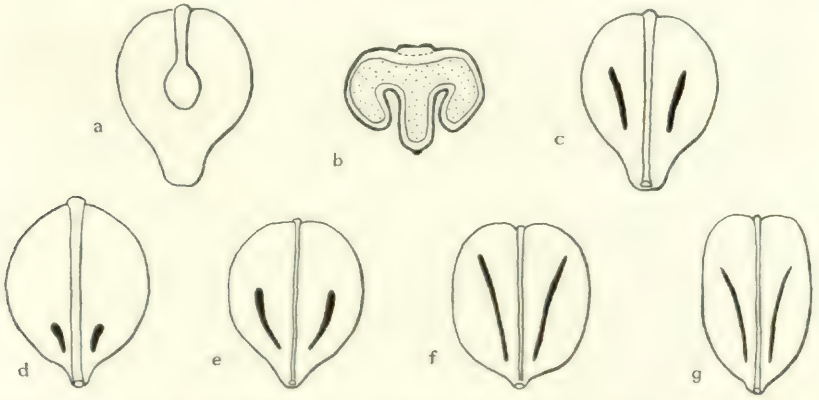

FIG. 1. Diagrams to show characteristic seeds of Vitaceae subfamily Vitoideae with outer membranaceous layer of seed coat removed; relative sizes of seeds modified for ease of comparison. a–c. *Vitis* (subg. *Vitis*) *Labrusca*: a, convex abaxial surface, showing "chalazal knot" with raphe extending to seed apex; b, cross section, showing thick sclerotesta, "chalazal knot," grooves flanking raphe, and endosperm (stippled); c, adaxial surface, showing raphe extending from hilum to seed apex with flanking grooves in black. d–g, adaxial surface of seeds to show variation in raphe and grooves: d, *Cissus incisa*; e, *Ampelopsis arborea*; f, *Parthenocissus quinquefolia*; g, *Vitis* (subg. *Muscadinia*) *rotundifolia*.

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KEY TO THE GENERA OF VITACEAE

General characters: *usually woody vines climbing by tendrils opposite the leaves; leaves alternate, simple or palmately 3–5-foliolate, rarely bipinnate; inflorescences opposite the leaves; flowers small, regular, 4–5-merous (except 2-carpellate gynoecium), hypogynous; stamens opposite the petals; nectariferous disc intrastaminal, conspicuous, rarely obscure; ovary 2-locular, with 2 subbasal, ascendent ovules in each locule; fruits 1–4-seeded berries; seed with a conspicuous abaxial chalazal knot and 2 deep adaxial grooves, one on each side of the raphe.*

A. Petals expanding at anthesis, distinct; inflorescence usually cymose, without a tendril; pith white.

B. Flowers 4-merous; inflorescence an umbel-like compound cyme (pleiochasium); leaves 3-foliolate, rarely simple. . . . . 1. *Cissus*.

B. Flowers 5-merous.
C. Nectariferous disc conspicuous, cupular, distinct at least in the upper part; inflorescence a thyrse, usually repeatedly bifurcate and corymb-like, rarely raceme-like; leaves simple or bipinnate; tendrils bifurcate, without adhesive discs. . . . . 2. *Ampelopsis.*
C. Nectariferous disc obscure, reduced and fused with base of ovary; inflorescence a pyramidal cymose panicle with monochasially branched rachis; leaves palmately (3)5-foliolate; tendrils monochasially 3–12-branched, developing adhesive discs at tips of their branches. . . . . 3. *Parthenocissus.*
A. Petals cohering at apex and falling off as a unit at anthesis; inflorescence a panicle, sometimes with a tendril; pith brown; leaves simple. . . . 4. *Vitis.*

1. **Cissus** Linnaeus, Sp. Pl. 1: 117. 1753; Gen. Pl. ed. 5. 53. 1754.

Deciduous [or evergreen] ± woody, sometimes ± fleshy [or herbaceous] vines [rarely tendrilless perennial herbs, shrubs, or small ± succulent trees]; tendrils continuous, simple or bifurcate, without [or very rarely with] adhesive discs; roots often tuberous. Leaves simple, unlobed or lobed, and/or palmately 3[–5]-foliolate, membranaceous [to leathery] or ± fleshy, petioled [rarely sessile]. Inflorescences compound umbel-like cymes (pleiochasia) without tendrils, each opposite a leaf [rarely terminal], continuous, the secondary branches sometimes bifurcate. Flowers 4-merous [exceptionally 5-merous], bisexual [or bi- and unisexual, the plants then polygamo-monoecious], greenish- or creamy-yellow, white, or purplish. Calyx cuplike, indistinctly shallowly 4-lobed to subentire. Petals 4, usually expanding, spreading at anthesis. Stamens 4. Nectariferous disc cuplike, adnate high up on the ovary [or distinct and 4-parted, or replaced by 4 distinct bowl-like glands], the free upper margin ± 4-lobed or crenate to subentire, spreading or upright. Stigma small; style rather long, ± filiform; ovary 2-locular, apparently incompletely so (in our species).[3] Berries subglobular-ovoid to -obovoid, 5–12 mm. in diameter, dark purple to black, usually 1(2)-seeded, inedible. Seed obovoid, indistinctly beaked at base; chalazal knot linear, on lower part of abaxial face, imperceptibly merging with the narrow, linear, salient raphe running toward seed apex on abaxial and down to hilum on adaxial face; 2 adaxial grooves short, oblong, near base of seed (FIG. 1, d); sides of seed indistinctly very coarsely reticulate. TYPE SPECIES: *C. vitiginea* L., $2n = 26$. (Name from Greek, *kissos*, an ancient name for ivy, applied by Linnaeus to this genus.)

A nearly pantropical genus (exclusive of Hawaii and Polynesia) of nearly 350 species, a few in the warmer parts of the temperate zones. Subgenera CISSUS (subg. *Eucissus* Planch.), of pantropical distribution,

[3] Flowers of a few random herbarium specimens of *Cissus incisa* and *C. trifoliata*, boiled and dissected, invariably showed ovaries with only a narrow central strip of the partition which bore two collateral ovules on each side at base. Additional material should be investigated before any conclusions are drawn.

and CYPHOSTEMMA Planch. (sometimes segregated as the genus *Cyphostemma* (Planch.) Alston), of the Old World Tropics, have been recognized. Three species of subg. CISSUS occur in our area.

Cissus incisa (Torr. & Gray) Desmoul., marine-vine, a stout vine with fleshy, three-foliolate or deeply three-parted leaves, usually occurs on limestone in hammocks or in rocky and sandy open woods and on bluffs, from central peninsular Florida to Texas, Arizona, and Mexico, north to Arkansas, Missouri, and Kansas. *Cissus trifoliata* L., of the West Indies, Mexico (?), and northern South America (?), differing in the always three-foliolate leaves with smaller, often flabellate, more regularly toothed leaflets, and smaller fruits, occurs in hammocks in southern peninsular Florida and on the Florida Keys. The very polymorphic, tropical American *Cissus sicyoides* L., with more or less membranaceous, simple, unlobed, medium-sized leaves, and often with long aërial roots, occurs in hammocks, from the Florida Keys northward in peninsular Florida to Polk County. The inflorescences of this species (sometimes also of *C. trifoliata*) frequently are greatly expanded and deformed by a smut, *Mycosyrinx Cissi* (DC.) Beck, the flowers being transformed into elongated subcylindrical formations containing spores of this fungus. The genus *Spondylantha* Presl was based on this monstrosity.

The few published data indicate an "anatomically parietal" placentation in a few investigated Asiatic species (Nair & Mani). Chromosome counts for 12 species are $2n = 22$, 24, 26, 28, 32, 44, ca. 45, 48, 50, and 96, suggesting that both aneuploidy and polyploidy have been of importance in the evolution of the genus.

The genus is closely related to the monotypic Laotian *Acareosperma* Gagnep., and probably to *Cayratia* Juss. The genus is in need of a modern revision.

The tuberous roots of *Cissus trifoliata* are reputedly poisonous. The aërial roots of *C. sicyoides* are locally used in Central America for wattling baskets, and leaves of this species seem to contain saponines and are locally used for washing linen in tropical America.

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2. **Ampelopsis** Michaux, Fl. Bor.-Am. **1:** 159. 1803; emend. Planchon in A. & C. de Candolle, Monogr. Phaner. **5**(2): 453. 1887.

Deciduous woody vines; tendrils usually few and scattered [or many and continuous], bifurcate, devoid of adhesive discs. Leaves membranaceous, simple or bipinnate [pinnate or palmate], long-petioled. Inflorescences few- to many-flowered thyrses, each opposite a leaf, continuous, often repeatedly bifurcate and corymb-like, more rarely elongated, raceme-like, the ultimate branches ending in usually umbel-like, crowded, sessile, 3-flowered dichasia. Flowers 5-merous [4-merous in 1 species], bisexual, greenish. Calyx very small, ± saucer-like. Petals 5, spreading at anthesis. Stamens 5. Nectariferous disc cupular, distinct except the lower part adnate to the ovary, shallowly lobed or crenulate to subentire on the margin. Stigma small, simple; style elongated, slender; ovary 2-locular, apparently incompletely so in our species. Berries subglobular to obovoid, 6–8 mm. in diameter, green, blue, or black, 1–4-seeded. Seed obovate to broadly obovate in outline, convex on abaxial, ± angular on adaxial side; chalazal knot ± spatulate, at or below center of abaxial side; raphe narrowly linear, salient on abaxial, threadlike on adaxial surface; 2 adaxial grooves oblanceolate, usually somewhat curved, in the lower half of seed (FIG. 1, e). LECTOTYPE SPECIES: *A. cordata* Michx.; see Britton & Brown, Illus. Fl. No. U. S. ed. 2. **2:** 509. 1913. (Name from Greek, *ampelos,* grapevine, and *opsis,* likeness, appearance; i.e., having the appearance of the vine, *Vitis vinifera.*)

A genus of about 22 species, of tropical and warm-temperate regions of Asia (19 species, centered in China) and North America (3 species); two indigenous and one naturalized species in our area. *Ampelopsis cordata* Michx., $2n = 40$, a high-climbing, nearly glabrous vine, the leaves simple, ovate, cordate or truncate at base, unlobed or slightly 3-lobed, coarsely and sharply toothed, the berries greenish or bluish, occurs in rich woods and bottomlands from northern Florida to Texas and Mexico, north to southeastern Nebraska, southern Illinois, southern Indiana, southern Ohio, and Virginia. It seems to be closely related to the eastern Asiatic *A. brevipedunculata* (Maxim.) Trautv. (*A. heterophylla* Sieb. & Zucc.), $2n = 40$, a more or less pubescent vine with ovate-cordate, 3-lobed, simple leaves and bright-blue berries, which is cultivated for ornament and is sporadically naturalized in at least North Carolina and Georgia (Small), northward to Ohio and New England. *Ampelopsis arborea* (L.) Koehne (*A. bipinnata* Michx.), pepper-vine, $2n = 40$, generally a high-climbing vine (or sometimes bushy), with bipinnate (or -ternate) leaves, rather small, coarsely toothed or incised leaflets, and dark-purple to black berries, occurs in swampy woods from southern Florida to Texas, north to Oklahoma, Missouri, southern Illinois, and to Virginia and Maryland. It is closely related to *A. orientalis* (Lam.) Planch., of Asia Minor. The relationships of the third North American species, the ternate-leaved *A. mexicana* Rose, of western Mexico (Sinaloa to Guerrero), remain uncertain.

Inflorescences showing transitions to tendrils, with a branch or the peduncle spirally coiled, have been frequently observed in *Ampelopsis cordata*. In at least our species, the septa of the ovary are not connate at the center. The genus appears to be homoploid, $2n = 40$ having been found in the six species investigated.

A close relationship to *Ampelocissus* Planch., *Vitis*, and especially to *Parthenocissus* has been assumed by various authors. The genus is in need of a modern revision.

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Under family references see BRANDT, LENGERKEN (pp. 343–359), SCHNEIDER (pp. 318–323, 1033, 1034), SUESSENGUTH (pp. 313–315), VATSALA, and VIALA & VERMOREL (1: 68–75. 1910).

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MEEHAN, T. The native flowers and ferns of the United States. vol. 2. v + 200 pp. *pls. 1–48*. 1879. [*Vitis indivisa* Willd. (= *Ampelopsis cordata*), 21–24, *pl. 6*.]

3. **Parthenocissus** Planchon in A. & C. de Candolle, Monogr. Phaner. **5**(2): 447. 1887.

Deciduous [rarely evergreen] high-climbing vines; tendrils intermittent, monochasially 3–12-branched, with [rarely without] adhesive discs at

tips of branches. Leaves palmately [very rarely pedately] (3)5(7)-foliolate, long petioled, leaflets medium sized to large, coarsely toothed, subsessile to long petiolulate. Inflorescences usually many-flowered cymose panicles with prolonged monochasially branched rachises [or corymb-like bifurcately branched thyrses], lacking tendrils, opposite the leaves, intermittent, and sometimes also terminal. Flowers 5-merous, bisexual [sometimes also functionally ♂], greenish. Calyx small, cupular, shallowly irregularly 5-lobed. Petals 5, concave, thickish, expanding at anthesis. Stamens 5. Nectariferous disc usually obscure, fused with the ovary base, distinguishable from the ovary by darker color, secretion of nectar, and anatomical structure [or rarely disc evident]. Stigma simple, small; style narrowly conical, short; ovary 2-locular, the septa meeting in the center and apparently not or weakly connate. Berries subglobular, 5–10 mm. in diameter, dark blue to black, often glaucous, 1–4-seeded, inedible. Seed obovate to obovate-suborbicular in outline, convex on the abaxial, angular, ± keeled on the adaxial side; chalazal knot round to short-spatulate, situated in or above the center of abaxial surface, extended to the seed apex into a linear ± salient raphe inconspicuous and threadlike on the adaxial side; 2 adaxial grooves narrow, cracklike, slightly curved, extending nearly from apex to base of seed (FIG. 1, f). LECTOTYPE SPECIES: *P. quinquefolia* (L.) Planch. (*Hedera quinquefolia* L.); see Britton & Brown, Illus. Fl. No. U. S. ed. 2. 2: 511. 1913. (Name from Greek, *parthenos*, virgin, and *kissos*, ivy; an equivalent of *vigne-vièrge*, the French name for the type species.)

A genus of about 15 species, of the temperate and tropical regions of eastern Asia and North America, centered in Asia (12 species); one species in our area.

Parthenocissus quinquefolia (*Ampelopsis quinquefolia* (L.) Michx., *A. hederacea* (Ehrh.) DC.),[4] Virginia creeper, woodbine, $2n = 40$, occurs

[4] Rehder (1905) presented strong arguments for regarding *Hedera quinquefolia* L. as a species of *Parthenocissus* developing adhesive discs on its tendrils. Consequently he applied *P. quinquefolia* (L.) Planch. to this species. Suringar supported Rehder's interpretation of the type species of the genus with numerous data from the pre- and early post-Linnaean literature. Graebner (1900, 1908, and 1928), however, was of the contrary opinion and applied *P. quinquefolia* to the species without adhesive discs, known at present as *P. vitacea* (Knerr) Hitchc. Rehder's view has generally been accepted by American and European botanists, but a few botanists have adopted Graebner's interpretation. Thus, in his *Catalogus Florae Austriae* (1: 414. 1957), Janchen treats *P. quinquefolia* as a species without adhesive discs on the tendrils, citing in its synonymy *P. vitacea* (Knerr) Hitchc. and *Hedera quinquefolia* L. The species with adhesive discs, generally known as *P. quinquefolia* (L.) Planch., Janchen calls "*P. pubescens* (Schldl.) Graebner (amplif. Janchen)" with "*P. quinquefolia* Rehder, Schneider, Fritsch, Hegi, Mansfeld, non Graebner" and "non *Hedera quinquefolia* L." in synonymy. Made in good faith, but hardly well founded, this action unfortunately returns confusion to the already stabilized nomenclature of the American species of *Parthenocissus*.

Gleason (1947) showed that *Vitis inserta* Kerner, on which *Parthenocissus inserta* (Kerner) Fritsch is based, "is merely a synonym of *P. quinquefolia*." Hence, the correct name for the species known under that name is *P. vitacea* (Knerr) Hitchc.

in hammocks and woods and on rocky banks from Cuba, the Bahamas, and southernmost Florida (including the Keys) north to Maine, Vermont, southwestern Quebec, New York, Ohio, Indiana, Illinois, Wisconsin, Minnesota, and southern Manitoba, west to Texas, and in Mexico and Guatemala (Huehuetenango). The species is variable, and several forms and varieties, mostly horticultural, have been distinguished. The most frequently encountered wild form of var. *quinquefolia* is f. *hirsuta* (Donn) Fern. (*P. hirsuta* (Donn) Small, *P. pubescens* (Schlecht.) Graebn.), with soft-pubescent lower surface of leaflets, young branchlets, and inflorescences. *Parthenocissus quinquefolia* var. *murorum* (Focke) Rehd., differing from the typical variety mainly in tendrils with 8–12 short branches (as against 3–8 elongated branches) and somewhat broader and thicker leaflets, has been recorded at least from Florida, the Bahamas, Cuba, and Mexico. The species is closely related to *P. laetivirens* Rehd., of central China.

Parthenocissus vitacea (Knerr) Hitchc.,[4] $2n = 40$, which differs from *P. quinquefolia* mainly in the bifurcately branched corymb-like inflorescences (with a tendency toward racemose branching), tendrils usually lacking adhesive discs, and somewhat larger berries and seeds, occupies a range north and west of our area, occurring from Nova Scotia and Quebec to southern Manitoba and Montana, south to New England, Pennsylvania, Ohio, Indiana, Illinois, Missouri, Kansas, New Mexico, western Texas, and Arizona. The closely related *P. heptaphylla* (Buckl.) Britt. ex Small, perhaps a variety or subspecies of the preceding, with (6–)7-foliolate leaves and smaller leaflets, seems to be restricted to central Texas.

The flowers in at least our species are proterandrous, and cross-pollination appears to be the rule. Bumblebees, honeybees, and some other Hymenoptera, Diptera, and Coleoptera have been recorded as pollinators. Chromosome numbers, known in four species, are invariably $2n = 40$. Hybridization (in cultivation, as well as in the wild) between *P. quinquefolia* and *P. vitacea,* assumed by Schneider (p. 316), can not be substantiated at present, since no authentic records of such hybrids have been available.

The genus seems to be closely related to *Ampelopsis*, as well as to *Ampelocissus* and *Vitis*. A modern revision of the North American species,

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Suessenguth (p. 312) adopted *P. vitacea* but made a misleading remark. Having questionably placed *Ampelopsis quinquefolia* DC. var. *vitacea* Knerr, Bot. Gaz. **18**: 71. 1893, in the synonymy of *P. vitacea* Hitchc., he noted, "fraglich ob hierher gehörig, da für sie Haftscheiben angegeben werden, für *P. vitacea* Hitchcock dagegen nicht." Apparently Suessenguth misunderstood the English description, since Knerr (*loc. cit.* 70) wrote, "The variety does not cling so closely to its support. In fact it is impossible for it to climb a wall or even a tree unless the bark be very rough, owing to the structure of its tendrils. It climbs more like the grape and the clematis . . . On examination the tendrils will be found to be more like grape tendrils, long curling and grasping by recurved tips, rather than short, digitate and clinging by disk-like expansions as in the case of the typical species [typical variety]."

based on field studies, with special regard to the morphology of inflorescences and tendrils, is desirable.

Both eastern North American species and the eastern Asiatic *Parthenocissus tricuspidata* (Sieb. & Zucc.) Planch. (*Ampelopsis tricuspidata* Sieb. & Zucc., *A. Veitchii* Hort.), Boston ivy, $2n = 40$, are valued ornamentals, used especially for covering arbors, rocks, bushes, and walls. Fruits of at least *P. quinquefolia* are said to be poisonous.

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4. **Vitis** Linnaeus, Sp. Pl. 1: 202. 1753; Gen. Pl. ed. 5. 95. 1754.

Deciduous, rarely evergreen, woody vines; bark of main stem and branches usually shreddy and exfoliating, without distinct lenticels, or rarely close, not exfoliating, with numerous lenticels; pith brown, usually interrupted by diaphragms within the nodes, rarely continuous through the nodes; tendrils usually bifurcate, rarely simple, not forming adhesive discs, intermittent, rarely continuous. Leaves simple [rarely palmately compound], often lobed, dentate. Inflorescences panicles (perhaps thyrses), each opposite a leaf, sometimes with a tendril at the apex of peduncle. Flowers 5-merous, fragrant, both bisexual and (at least functionally) unisexual [rarely bisexual only], the plants polygamo-dioecious to trioecious. Calyx very small, saucer-like, or obsolete, slightly 5-dentate to entire. Petals 5, coherent at apex, separating only at base, falling off as a cup at anthesis. Stamens 5, straight in ♂ and bisexual flowers, reflexed and with sterile pollen [or exceptionally wanting] in ♀. Nectariferous disc of 5 flat, ± distinct or coherent glands alternate with the stamens. Gynoecium rudimentary in ♂ flowers; stigma small; style conical, short; ovary 2-locular. Berries globular [to ellipsoid], 5–25 mm. diameter [or more in cultivars], purple to black, more rarely whitish, pink, bronze, or greenish, glaucous or not, 2-locular, 2–4-seeded. Seeds mostly pyriform, ± distinctly beaked at base, more rarely obovate to obovate-oblong and beakless; chalazal knot round to elliptic, mostly in the center of the abaxial side; 2 adaxial grooves deep, rather long, narrow, ± curved in the upper part (FIG. 1, a–c, g). LECTOTYPE SPECIES: *V. vinifera* L., $2n = 38$; see Britton & Brown, Illus. Fl. No. U. S. ed. 2. 2: 505. 1913. (Classical Latin name of the vine, *V. vinifera*.)

A genus of nearly 60 species, of temperate and tropical regions of the Northern Hemisphere, centered in China and in eastern North America. Two very distinct subgenera have been recgonized, subg. VITIS, $2n = 38$, comprising the vast majority of species, and subg. MUSCADINIA, $2n = 40$?, including three American species. Morphological differences between the subgenera (see below), coupled with different chromosome numbers and a rather strong genetic barrier, seem to favor the generic segregation of subg. MUSCADINIA. Since, however, cytological data are known only in one of the three species of the latter, and the morphological differences can be evaluated only after a thorough study of the related genera. *Muscadinia* is retained here as a subgenus of *Vitis*.

Subgenus VITIS (§ *Euvitis* Planch.). Bark of the main stem and branches shreddy and exfoliating, without distinct lenticels; pith interrupted by diaphragms within the nodes; tendrils forked; infructescences usually elongated, many fruited; seeds usually pyriform, ± distinctly beaked at base, smooth on the abaxial side. About 17 species (or perhaps fewer) in

our area. There is no agreement as to the interrelationships of these; the sequence in which they are mentioned below reflects only increasing area of occurrence, not taxonomic relationship. The species of subg. VITIS often intergrade, and their delimitation appears to be rather difficult; hence the species concepts of various authors differ, and the specific status of some species is still uncertain. A thorough taxonomic and nomenclatural revision is needed.

Vitis illex Bailey (*V. cordifolia* var. *sempervirens* Munson), *V. Smalliana* Bailey, *V. sola* Bailey (apparently closely related to and perhaps conspecific with *V. tiliifolia* HBK., of the West Indies, Central America, and northern South America), and *V. Shuttleworthii* House (*V. coriacea* Shuttlew. ex Planch. 1887, not Miq. 1863) are restricted to Florida. *Vitis araneosa* Le Conte (*V. rufotomentosa* Small), the specific status of which is uncertain, ranges from Florida to Louisiana and southeastern Virginia. The Mexican-Texan *V. Berlandieri* Planch., $2n = 38$, and *V. candicans* Engelm., mustang grape, $2n = 38$, seem to occur in our area at least in western Arkansas. *Vitis Lincecumii* Buckley, $2n = 38$, of Texas, Oklahoma, Arkansas, Louisiana, and southeastern Missouri, recently has been recorded from Scott County, Tennessee. *Vitis Baileyana* Munson is found in upland and mountain areas in Alabama and northwestern Georgia, western South and North Carolina, and eastern Tennessee, north to southeastern Virginia, West Virginia, and southeastern Kentucky. The taxonomic status of *V. Lincecumii* and *V. Baileyana* needs further clarification. While Gleason (New Britt. Brown Illus. Fl. NE. U. S. 2: 517. 1952) suggested that both might be not yet fully stabilized species of hybrid origin, Steyermark (Fl. Missouri 1036, 1037, 1040. 1963) reduced them to the synonymy of *V. aestivalis* var. *aestivalis* and *V. vulpina*, respectively. *Vitis palmata* Vahl (*V. rubra* Michx.), $2n = 38$, ranges from northeastern Texas, northern Louisiana, and central Mississippi north to western Oklahoma, central Missouri, southern Illinois and southern Indiana, west to southern Kentucky and western Tennessee. *Vitis rupestris* Scheele, sand-grape, $2n = 38$, has a similar range, but does not seem to occur in Mississippi and Louisiana; reports of this species from Pennsylvania, the District of Columbia, and North Carolina appear to be based on introductions and escapes.[5]

Five additional species of subg. VITIS are of wide distribution in eastern North America: *Vitis vulpina* L. (*V. cordifolia* Lam.), frost-grape, chicken-grape, $2n = 38$; *V. Labrusca* L., fox-grape, $2n = 38$; *V. aestivalis* Michx., summer-grape, pigeon-grape; *V. cinerea* Engelm. ex Millard (including var. *cinerea*, graybark-grape, $2n = 38$, and var. *floridana* Munson, sometimes regarded as a distinct species, *V. Simpsonii* Munson); and the most widely distributed species of North America, *V. riparia* Michx. (*V. vulpina* of authors, not L.), frost-grape or river-bank-grape,

[5] In his *Spring Flora of the Dallas-Fort Worth Area, Texas*, Shinners stated, "The name of this species is misapplied by Fernald and Rehder to plants extending north through and far beyond our area." Unfortunately, the basis for this statement was not explained.

which occurs from New Brunswick and Quebec to Manitoba and Montana, south to Virginia, Tennessee, Arkansas, Texas, and New Mexico. *Vitis argentifolia* Munson (*V. aestivalis* var. *argentifolia* (Munson) Fern.; *V. bicolor*, of authors) has a range similar to that of *V. aestivalis* and is usually regarded as a variety of it. Since both seem to occur together within nearly the same range, it appears to be more appropriate to regard *V. argentifolia* either as a form of *V. aestivalis* or as a distinct species. The latter solution seems preferable until further study clarifies the problem.

Subgenus MUSCADINIA (Planch.) Rehd. (*Muscadinia* (Planch.) Small). Bark of main stem and branches close, lenticellate, not exfoliating; pith continuous through the nodes; tendrils simple; infructescences very short, few-fruited; seed obovate to oblong-obovate, scarcely beaked, usually transversely wrinkled on the abaxial side. A strictly American subgenus of two or three species, in the southeastern United States, the West Indies, and Mexico; two species in our area.

Vitis rotundifolia Michx. (*M. rotundifolia* (Michx.) Small), muscadine, southern fox-grape, scuppernong, $2n = 40$, occurs in hammocks, swamps, open woods, thickets, and riverbanks, from southern Florida to Texas, northward, mostly on the Coastal Plain, to Virginia, Delaware, southwestern West Virginia, southeastern Kentucky, Tennessee, extreme southeastern Missouri, and Oklahoma. Leaves in this species are distinctive but rather variable; berries are subglobular, 12–25 mm. in diameter, with thick, tough, purple-black to bronze (in the cultivar 'Scuppernong') skin and tough, sweet pulp with a characteristic musky flavor. Long aërial roots are often present. This species is highly resistant to virus and fungal diseases and insect pests, especially to phylloxera and nematodes. *Vitis Munsoniana* Simpson ex Munson (*M. Munsoniana* (Simpson ex Munson) Small), closely related to and differing from the preceding mainly in the sour, not musky-flavored, black, persistent berries, 8–15 mm. in diameter, with a tender skin and pulp and smaller seeds, is found in hammocks and scrub, in peninsular Florida and Georgia, on the Florida Keys, and in the Bahamas. The leaves, very similar to those of *V. rotundifolia*, are said to be persistent, at least in southern Florida. *Vitis Popenoei* Fennell (*V. vulpina* var. *yzabalana* S. Wats.), of Mexico (Veracruz) and Guatemala (Izabal), seems to be a distinctive species closely related to *V. rotundifolia*. However, fruits and seeds, cytology, and distribution of this species need to be studied. Records of *V. rotundifolia* from Mexico apparently are referable to *V. Popenoei*.

Although the flowers in the genus usually are 5-merous, the number of floral parts (petals and stamens) may vary from three to six (nine), the gynoecium, however, being usually 2-, rarely 3-carpellate (in 6(9)-merous flowers). While most of the cultivars, especially of *Vitis vinifera*, possess bisexual flowers, the wild species usually have bisexual, functionally pistillate, and staminate flowers, the latter with rudimentary gynoecium. Regarding the distribution of sexes, the plants may be polygamo-dioecious (androdioecious; rarely gynodioecious in some cultivars) or trioecious,

more rarely dioecious (with only staminate and functionally pistillate flowers). Cross-pollination seems to be the rule, although in many cultivated varieties with bisexual flowers self-pollination also occurs. Data on pollinating agents of our species are few, but bees seem to be most important.

Chromosome numbers, known in 21 species and numerous cultivars, are invariably $2n = 38$ in the species of subg. *Vitis*, and $2n = 40$ in *V. rotundifolia*. Polyploidy within the genus is rare, and $2n = 57$ and 76 have been found in a few cultivars of *V. vinifera*. "So it is to be considered that speciation in this genus is achieved by intrachromosomal variations brought about by accumulation of genic differences" (Vatsala).

Although wild hybrids have rarely been recorded, the species of subg. *Vitis* hybridize freely, and numerous, sometimes complex, artificial hybrids between *Vitis vinifera* and some North American species, as well as between some of the latter, have been produced. There seems to be, however, a genetic barrier between the species of the subgenera. While the cross *V.* (*Muscadinia*) *rotundifolia* ♀ × *V. vinifera* ♂ has always been unsuccessful, the reciprocal cross resulted in a highly sterile F_1 ($2n = 39$). Two such hybrids have recently been made fully fertile by chromosome doubling with colchicine, and a small population of tetraploids has been raised from the artificial amphiploids (cf. Dermen, 1964). A complex triploid ($2n = 59$) hybrid, (*V. Lincecumii* × *Labrusca* × *vinifera*) ♀ × *V. rotundifolia* ♂, which bears only staminate flowers, has been produced.

A close relationship with *Ampelocissus* and a more distant one with *Ampelopsis* and *Parthenocissus* have been assumed by various authors. According to Levadoux, Boubals, and Rives, "In the family of Vitaceae, it is possible to distinguish a comparium containing the genera with $2n = 40$ chromosomes [*Ampelocissus, Ampelopsis, Parthenocissus*, and *Vitis*]. In this comparium there appears a remarkable exception, the cenospecies *Euvitis* [*Vitis* subg. *Vitis*] to which nearly all the cultivated vines belong, and which is characterized by a chromosome number of $2n = 38$. The linnean species, traditionally differentiated within this cenospecies, are ecospecies between which no genetical barrier can be observed."

The genus is of great economic importance for the edible fruits from which raisins, grape juices, and wines are made. The horticultural varieties of economic importance have originated from *Vitis vinifera* (including extremely numerous cultivars), *V. Labrusca* (e.g., cultivars 'Concord', 'Champion', 'Chautauqua', and others, collectively known as *V. labruscana* Bailey), *V. aestivalis*, and *V. riparia*, and from crosses between certain of these species. In the United States, cultivars of *V. vinifera* are restricted to the Mediterranean-type climate of California; but numerous cultivars derived from hybrids of *V. vinifera* with cultivars of the hardy American *V. Labrusca* are widely grown under the climatic conditions of the eastern United States. All of the latter have a characteristic aroma and produce wines quite different from those from *V. vinifera*. Within the range of *V. rotundifolia* its cultivars are widely grown for the fresh

fruit used for home and local consumption and in the production of a distinctive wine.

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The vast number of references has been reduced here primarily to those either of general interest or dealing specifically with the southeastern United States. Under family references see especially ADKINSON, ARBAUMONT, BEILLE (pp. 105, 107–109), BOUBALS (1959; 1961), BRANDT, DARWIN (pp. 79–83), KIRCHHEIMER (pp. 1–9, 118–129), NAIR & MANI, SCHNEIDER (pp. 301–312, 1032, 1033), SUESSENGUTH (pp. 283–299; bibliography, pp. 174–179, 283, 284, 296, 297–299, and 334–337 [cultivars]), TROLL (pp. 30–32, 627, 628), VATSALA, and VIALA & VERMOREL (especially **1:** 109–718. *pls. 1–70.* 1910).

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DATES OF PUBLICATION OF THE JOURNAL LINNAEA: FURTHER EVIDENCE

H. E. MOORE, JR., AND C. E. WOOD, JR.

FOSTER HAS RECENTLY REVIEWED the problem of determining the dates of publication of the nineteenth-century periodical *Linnaea* in which a very large number of plants were described and named between 1826 and 1882. His list brought together the partial data published by six previous authors and other evidence adduced from articles in *Linnaea* itself, from reviews or comments in contemporary publications, and from a few other sources. In spite of these detective efforts, accurate dates have been lacking for many parts and volumes.

One of the difficulties in dating this, and a number of other botanical periodicals in which the title-page date of a volume may differ greatly from that of the actual publication of the individual parts, stems from the formerly widespread practice of discarding the covers of the parts when the volumes were bound. Thus, the dates of publication of the parts of only a few volumes of *Linnaea* have been taken previously from their original covers, these being missing in most sets which have been consulted. We were therefore happily surprised in August, 1964, when, having occasion to check a reference to *Linnaea* in the library of the Royal Botanic Garden, Edinburgh, we found that of the complete run of forty-three volumes, twenty-one (20–28, 32–43) have the original covers of the six or seven component parts (*Hefte*) bound in at the back. Each cover is dated with month and year and includes a table of contents and sometimes notes which provide additional data about the date of publication of the plates and the index (*Register*). Since throughout most of its history *Linnaea* seems to have been behind schedule, these cover dates may reasonably be considered the *earliest* possible for each *Heft* and should be taken as the date of publication, unless other evidence is available, as in the case of parts of volumes 42 and 43, the dates of which are given by Van Steenis-Kruseman and Stearn as one to six months later than the cover date. All other cover dates in the list which follows are in general accord with Foster's list, which in many instances provides the *latest* possible publication date.

To avoid duplication of effort, it should also be mentioned that we examined an incomplete run of *Linnaea* in the library of the University of Edinburgh and that Moore examined two sets at Oxford University (Radcliff Science Library and library of the Botany Department), but in all volumes the original covers are missing.

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Bailey Hortorium, Cornell University
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COMPARATIVE ANATOMY OF THE LEAF-BEARING CACTACEAE, XIII

THE OCCURRENCE OF WATER-SOLUBLE ANISOTROPIC BODIES IN AIR-DRIED AND ALCOHOL-DEHYDRATED LEAVES OF PERESKIA AND PERESKIOPSIS

I. W. BAILEY [1]

IN A PRELIMINARY SURVEY of the occurrence of crystals in the leaf-bearing Cactaceae (Bailey 1961), I noted the common presence in various species of *Pereskia* of brown isotropic bodies during earlier stages of the clearing of leaves in three per cent sodium hydroxide. Although isotropic in polarized light, the radial striations and occasional concentricities of these bodies superficially resembled those that occur in certain "spherocrystals" of calcium oxalate reported upon in the Cactaceae by Mobius (1885). They differed fundamentally, however, from the abundantly occurring druses and other crystalline forms of calcium oxalate in the family which are insoluble and retain their anisotropy in dilute solutions of sodium hydroxide. I concluded that the chemical composition and the factors involved in the formation of the isotropic bodies merited detailed investigation.

Having obtained more extensive collections of *Pereskia*, I now find that of 14 putative species of the genus all exhibit a tendency to form more or less numerous bodies comparable to those previously reported upon (Bailey 1961). This is true in the case of leaves from herbarium specimens of 11 species collected from plants growing in their native habitats and, likewise, in the case of leaves of 14 species preserved in formalin acetic alcohol (FAA).[2] Furthermore, the normal living leaves of eight species, although they have formed abundant druses of calcium oxalate, do not contain such bodies, but tend to develop them when the leaves are air dried or are transferred to alcohol varying in dilutions of from 95 to 50 per cent.

In the ordinary white light of a microscope the crystalline contents of the bodies are colorless. In polarized light they are as strikingly birefringent as the druses of calcium oxalate (FIG. 1). When dehydrated leaves are placed in a dilute solution of sodium hydroxide, the bodies rapidly lose their birefringence and commonly turn brown (FIG. 2). Upon prolonged treatment in alkali, the isotropic residues of the aniso-

[1] This investigation was supported by a grant from the National Science Foundation. I am indebted to the American Philosophical Society for the loan of a Wild microscope.

[2] Forty per cent formaldehyde, five parts: glacial acetic acid, five parts: 50 per cent ethyl alcohol, ninety parts.

tropic bodies ultimately lose their striated and other internal structural features and dissolve (Bailey 1961, *figs. 30–33*). This behavior is in marked contrast to that of druses and small individual units of calcium oxalate which, in the same leaves, remain insoluble and retain their anisotropy (Fig. 2). That the birefringent bodies are not composed of calcium oxalate is indicated, not only by their behavior when transferred to dilute sodium hydroxide, but also by their *solubility in water at ordinary room temperatures*.

In *Pereskia*, the size, form, and abundance of the water-soluble birefringent bodies varies more or less extensively in different collections of a taxon, in different leaves of the same plant, and in different layers of the same leaf. The larger more conspicuous bodies commonly are composed of a group of adjacent cells filled with compact birefringent contents which frequently exhibit fine striations oriented radially toward the center of the body (Fig. 5). Smaller bodies of spherical or angular form have a similar compact crystalline composition, but fewer adjacent cells are concerned in their development. In some cases, single large independently occurring cells of the mesophyll are not completely filled with crystalline contents, but may contain one or more small, spherical, radially striated bodies or hemispherical striated ones attached to the walls of the cell.

When many diversely dehydrated leaves of *Pereskia* are examined, some of them contain, in addition to larger bodies, minute water-soluble, birefringent units diffused throughout parts of the mesophyll (Fig. 4). These units vary markedly in crystalline form from rotund to rectangular, diamond-shaped, slender boat-shaped, and thin angular platelets. Some of the larger ones appear to arise by fusion of smaller units forming rings or spheres with or without isotropic interiors. These birefringent units, not only are water soluble, but also lose their anisotropy and turn brown in dilute sodium hydroxide.

At times, certain crystalline forms of the smaller units tend to be aggregated in varying degrees of compactness. For example, as illustrated in Fig. 3, single diamond-shaped crystals may be surrounded by a layer of aggregated crystals of different form. In other cases, groups of adjacent cells contain aggregations of small birefringent units in varying degrees of compactness. There appear to be transitional forms of crystallization between such structures and the commonly occurring extreme form illustrated in Fig. 5. At times, large bodies of the latter general form, having compact radially striated crystalline interiors, are jacketed by flat, more or less rectangular, birefringent units which are loosely aggregated and haphazardly oriented.

I have not encountered slender, much elongated, needle-like crystals occurring independently in *Pereskia*. However, particularly when living leaves are dehydrated in 95% alcohol, aggregations of such crystals may be formed in a few adjacent cells subtending stomata (Fig. 6). Where the elongated crystals are oriented parallel to one another, the aggregation may superficially resemble raphides of calcium oxalate, but the fascicles are not confined to single enlarged cells (i.e., idioblasts), are not embedded in

mucilage, and are water soluble. Very infrequently one encounters a radially oriented aggregation of such needle-like crystals in a single unusually large cell of the mesophyll (FIG. 7).

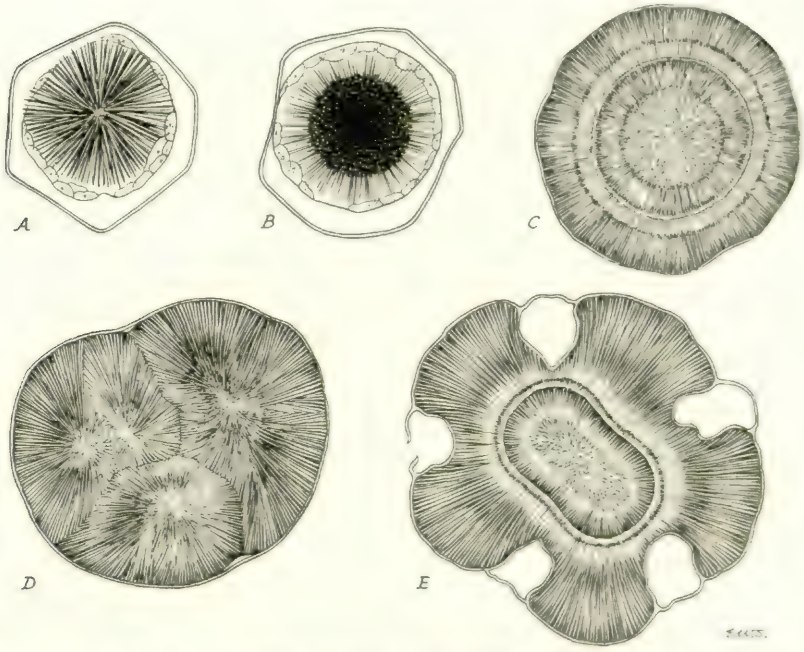
It is evident from observations recorded in preceding paragraphs that the birefringent structures induced during dehydration of the leaves of *Pereskia* exhibit more extensive variability in crystalline form than do druses of calcium oxalate persisting from the living condition in the same leaves. However, it is significant that, in spite of the diversity in the induced forms of crystallization, all of them are characterized by their solubility in water and by their similar behavior when transferred to dilute sodium hydroxide. It is not obvious at present why some dehydrated collections of a taxon or clone form the bodies, whereas others do not; why some leaves of a shoot contain them, when adjacent leaves are without them; and why some parts of a leaf have them, when other parts are devoid of them. Nor is it evident what factors are concerned in producing the variability in forms of crystallization. More detailed and extensive investigations, particularly adequate chemical analyses, starting with normal living leaves are highly desirable for elucidating such uncertainties.

In 36 collections of *Pereskiopsis* of varying taxonomic affinities, kindly collected and preserved for me in FAA by Boke, Moran, Kimnach, and others, a majority of 20 has leaves and occasionally young stems containing water-soluble birefringent bodies of varying abundance, sizes, and diversified crystalline forms. The largest of these bodies, up to and exceeding 600 microns in diameter, are much larger than the largest of those that occur in *Pereskia* (compare the contrasting sizes at the same magnification in FIGS. 1, 8, & 9). In addition, the larger birefringent bodies of *Pereskiopsis* differ markedly in their internal crystalline composition from those of *Pereskia*.

In *Pereskiopsis*, the larger bodies of multicellular origin tend to be rings or disks of varying thickness oriented periclinally in relation to the external surfaces of leaves and young stems. They are readily detectable without magnification, appearing superficially as embossed white pustules in the surfaces of leaves and stems which shrink during dehydration in FAA. In some of these bodies, all of the cells in the interior of the body are devoid of crystalline content, except for cells which contained druses of calcium oxalate in the living leaf or stem. In such a body, the isotropic core is jacketed by an anisotropic layer of varying thickness which appears as a birefringent ring in polarized light. More frequently the bodies have a cell with water-soluble birefringent contents at its center surrounded by an isotropic zone (which may contain water-insoluble druses of calcium oxalate) and, in turn, by an outer birefringent one having more or less numerous outwardly projecting bulges (FIG. 9). Less frequently most cells in the interior of a body may contain loosely aggregated water-soluble crystals (FIG. 8).

The individual crystals in these large birefringent bodies vary markedly in size, form, degree of aggregation, and orientation. Particularly in the outer birefringent zone of the bodies, many of the constituent cells exhibit

a conspicuous tendency to contain slender, elongated, more or less needle-like crystals oriented radially toward the center of the body. Similar forms of crystallization and orientation may be present in the central cell of a body. In the case of the large outwardly bulging cells illustrated in FIG. 9, some of them may have needle-like, radially oriented crystals in their inner or outer parts, whereas remaining parts of the cell contain minute widely diffused birefringent specks resembling "crystal sand."



TEXT-FIGS. A–E. Crystalline bodies in large cells of mesophyll of *Pereskiopsis* as seen in nonpolarized light. × 300. A–D. *Pereskiopsis* aff. *rotundifolia* (*Boke B-1*): A, radially oriented needle-like crystals in plasmolyzed cell; B, crystalline form at the center concealed by black specks; C, concentric layering of needle-like crystals; D, four centers of crystallization in a large cell. E, *Pereskiopsis porteri* (*Kimnach 76*): much-elongated needle-like crystals extending outwardly into adjacent cells of the mesophyll. Drawn by Elmer W. Smith.

Some dehydrated collections of *Pereskiopsis* contain smaller, more nearly spherical bodies. Some of these, when viewed in optical section (FIG. 10), resemble the larger body illustrated in FIG. 9. A single cell with birefringent contents at the center of the body is surrounded by an isotropic layer and, in turn, by an outer anisotropic one. In other cases, the bodies are birefringent throughout, their central part exhibiting very narrow anisotropic concentricities partly concealed in FIG. 11 by four positions of extinction when viewed in polarized light. The crystalline contents of the cell in the center of such bodies may be deposited at times in similar con-

centricities (FIG. 10), whereas in other cases the central cell contains larger elongated units resembling those that occur in cells of the external parts of the bodies (FIG. 11). It is significant in this connection, however, that the longer axis of the crystalline units — regardless of extreme variations in size and form — tend to be radially oriented toward the center of the bodies. It should be noted, in addition, that cells, particularly in the interior of the larger bodies, not infrequently contain black granular contents which tend to obscure internal crystalline configuration when the bodies are viewed in polarized light.

Some of Dr. Boke's collections of *Pereskiopsis* preserved in FAA in their native habitats (particularly in his *B-1*, *B-18*, *B-20*, *B-22*, and *B-31*, with putative affinities to *P. aquosa*, *P. chapistle*, *P. rotundifolia*, or *P. spathulata*) contain, in addition to multicellular bodies, large independently distributed cells with water-soluble crystalline contents. Some of these cells (TEXT-FIG. A) have slender, elongated, radially oriented units resembling the configuration that occurs so infrequently in *Pereskia* (FIG. 7). Occasionally a large cell may contain several bodies of similar crystalline form (TEXT-FIG. D). The contents of other cells of the same leaf (TEXT-FIG. C) commonly exhibit conspicuous concentricities, due apparently to variations in the size or form of the crystalline units in successive zones of their deposition. In some cases the longer needle-like crystals of the external zone extend outwardly into parts of adjacent cells forming expanded bodies of more or less conspicuously lobed or angular forms (TEXT-FIG. E). At times, the inner parts of some of the cells contain numerous black isotropic specks (TEXT-FIG. B) which tend to obscure the anisotropy in the interior of concentric configurations.

DISCUSSION AND CONCLUSIONS

The water soluble birefringent bodies of *Pereskia* and *Pereskiopsis* are formed during dehydration of the "sap" of living cells. In *Pereskia*, the larger bodies are remarkably similar regardless of whether leaves are air dried, as in the case of herbarium specimens, immersed in 95%, 70%, and 50% ethyl alcohol, or preserved in FAA. In none of my numerous collections of different species of the genus do larger crystalline bodies comparable to those of *Pereskiopsis* occur. Although highly variable, the forms of crystallization differ so consistently in *Pereskia* and *Pereskiopsis* as to provide, even in herbarium specimens, an additional criterion for separating the genera taxonomically.

Young green stems in some of my collections of *Opuntia* (preserved in FAA) contain water soluble birefringent bodies of sizes and crystalline forms resembling those that occur in *Pereskiopsis*, suggestive of possible taxonomic relationship. Furthermore, the "spherocrystals" in *Echinocactus*, *Mamillaria*, and *Anhalonium* observed and briefly discussed by Lauterbach (1889) and Michaëlis (1896) were found in tissues treated with alcohol. It now appears that these anisotropic bodies, unlike normally occurring druses and other forms of calcium oxalate, belong in a special

water soluble category. The occurrence of such bodies in all three subfamilies or tribes of the Cactaceae at least suggests that a tendency for their formation during dehydration of the "sap" of living cells may be widely distributed throughout this characteristically xerophytic family.

Since the publication of Schleiden's (1845) classical paper, the Cactaceae have proved to be a family having extraordinarily abundant druses and other water insoluble crystalline forms of calcium oxalate in their tissues, indicative, in turn, of the production of excessively large amounts of oxalic acid in their metabolism. It is significant in this connection that in living cacti, crystals of calcium oxalate occur in the mesophyll of leaves (where present) and in parenchymatous cells of the pith, cortex, xylem, and phloem of both stems and roots. In contrast to this, the water soluble crystals formed during dehydration of "sap" in *Pereskia* and *Pereskiopsis* occur primarily in the chlorenchyma of leaves and in the cortex of green stems which function in photosynthesis.

Unfortunately, owing to numerous complexities and uncertainties, it does not appear possible at present to determine the exact chemical composition of the water soluble bodies merely by their forms of crystallization. For example, upon the basis of superficial resemblances in forms of crystallization, it has been suggested by Lauterbach (1889) and others that the birefringent bodies in dehydrated tissue of the Cactaceae are composed of inulin or related substances. Such is not the case in collections available to me where tests for such composition of the crystalline bodies are negative. That calcium is involved in the chemical composition of the larger birefringent bodies of *Pereskiopsis* may be demonstrated by treatment in sulphuric acid. When transferred to this acid the birefringence of the bodies is rapidly reduced, but is quickly restored by the formation of crystals of calcium sulphate. The transition to calcium sulphate tends to occur more rapidly than in druses of calcium oxalate present in the same tissue.

It is of interest in these connections that similar forms of crystallization in alcohol have been encountered in certain representatives of other families of angiosperms, viz. cactus-like euphorbias, *Mesembryanthemum* (Aizoaceae), *Basella* (Basellaceae), *Ceropegia* and *Stapelia* (Asclepiadaceae), *Galtonia* (Liliaceae), and *Nolana* (Nolanaceae). Belzung (1893), Belzung and Poirault (1892) and Mirande (1898), following the earlier investigations of Hansen (1888), Leitgeb (1888) and others, concluded upon the basis of extensive microchemical and other tests that calcium malate and calcium "malophosphate" (?) are concerned in such plants during the formation of water soluble crystals when their tissues are dehydrated in alcohol. A similar conclusion was reached subsequently by Kean (1931) in his investigation of *Mesembryanthemum*.

Although these investigations are suggestive rather than conclusive from modern chemical points of view, they do indicate that the water soluble crystals are in all probability calcium salts of organic acids, occurring in close association with calcium phosphate. It is unlikely that the crystals are composed solely of calcium phosphate, as suggested by earlier investi-

gators, since such crystals are almost insoluble in water as are the crystals of calcium oxalate. That dehydration in alcohol is not essential for their formation is clearly indicated by their typical occurrence in the dehydrated cellular "sap" of air dried leaves, for example in herbarium specimens.

At present, cumulative circumstantial evidence from these phylogenetically highly specialized genera, in correlation with the behavior in the characteristically xerophytic Cactaceae, raises a fundamentally significant question. Are there evolutionary changes in the metabolism of angiosperms (viz. those having excessive succulence) which lead to the formation of unusually large amounts of such organic acids as oxalic, malic, etc.? The phenomena are highly complex and variable and involve various uncertainties. An adequate answer to the question will involve active and sustained cooperation between botanists and chemists.

Preliminary observations on the only normal living leaves of *Pereskiopsis* available to me thus far (from Dr. Boke's culture of his *B-18*) suggest that this genus may provide more favorable material for studying successive stages in the formation of birefringent bodies during dehydration than does *Pereskia*. A more detailed discussion of the phenomena will be undertaken when living leaves and young stems of other species of *Pereskiopsis* become available.

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EXPLANATION OF PLATES

PLATE I

FIGS. 1–4. Parts of leaves of *Pereskia* photographed in polarized light. 1, *Pereskia aculeata*, showing birefringence of large water-soluble bodies and anisotropy of small druses of calcium oxalate in dehydrated leaf, × 114; 2, *P. aculeata*, showing loss of birefringence by the water-soluble bodies and retention of anisotropy by druses of calcium oxalate after treatment in dilute sodium hydroxide, × 114 (in this leaf both the water-soluble bodies and the druses were larger than in FIG. 1); 3, *Pereskia corrugata*, diamond-shaped crystals surrounded by aggregations of small crystals of different form, × 180; 4, *P. corrugata*, showing diffusely distributed minute water-soluble crystals, × 114.

PLATE II

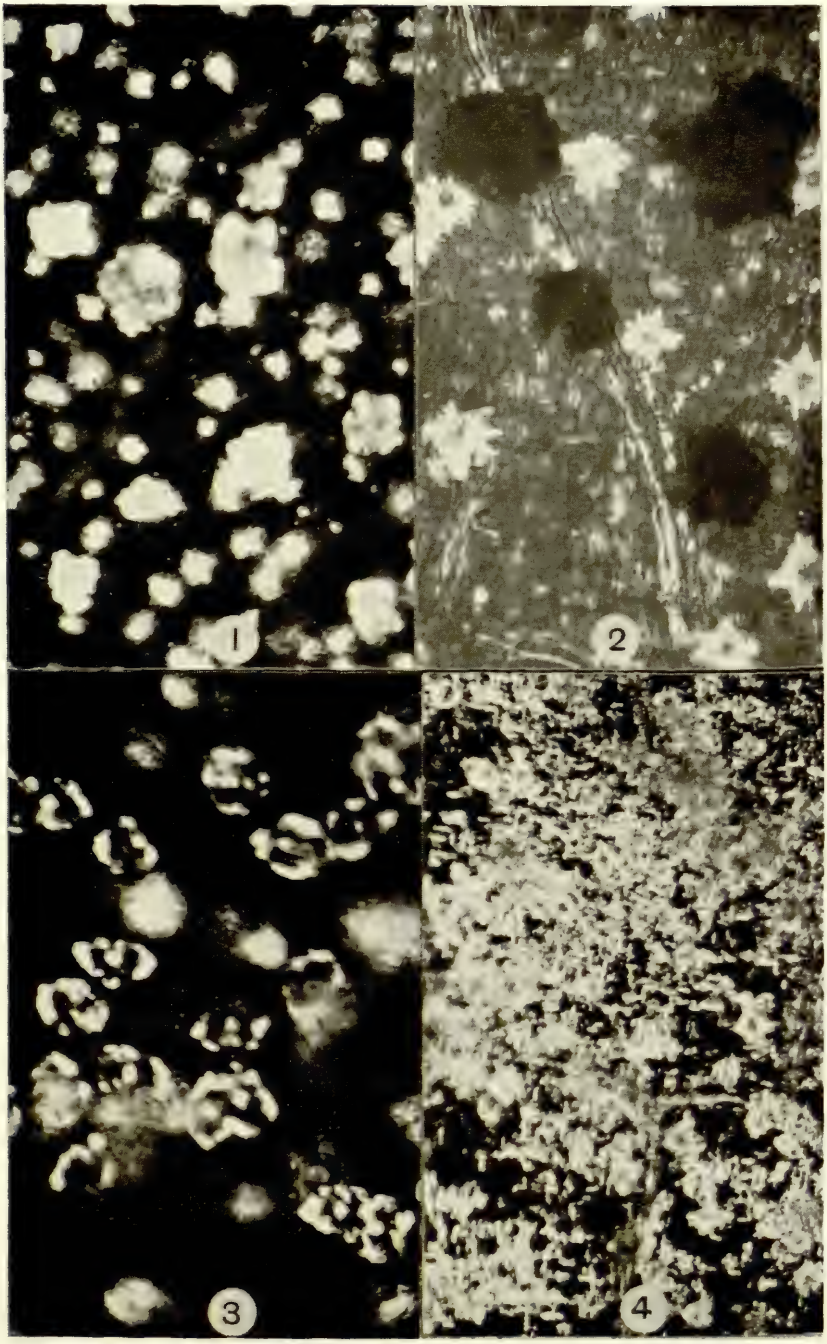
FIGS. 5–7. Water-soluble birefringent bodies of *Pereskia* photographed in non-polarized light, × 260. 5, *P. corrugata* showing large compact radially striated body; 6, *P. sacharosa* showing fascicles of needle-like crystals in cells subtending stomata; 7, *P. pititache* showing radially oriented needle-like crystals in a single large cell.

PLATE III

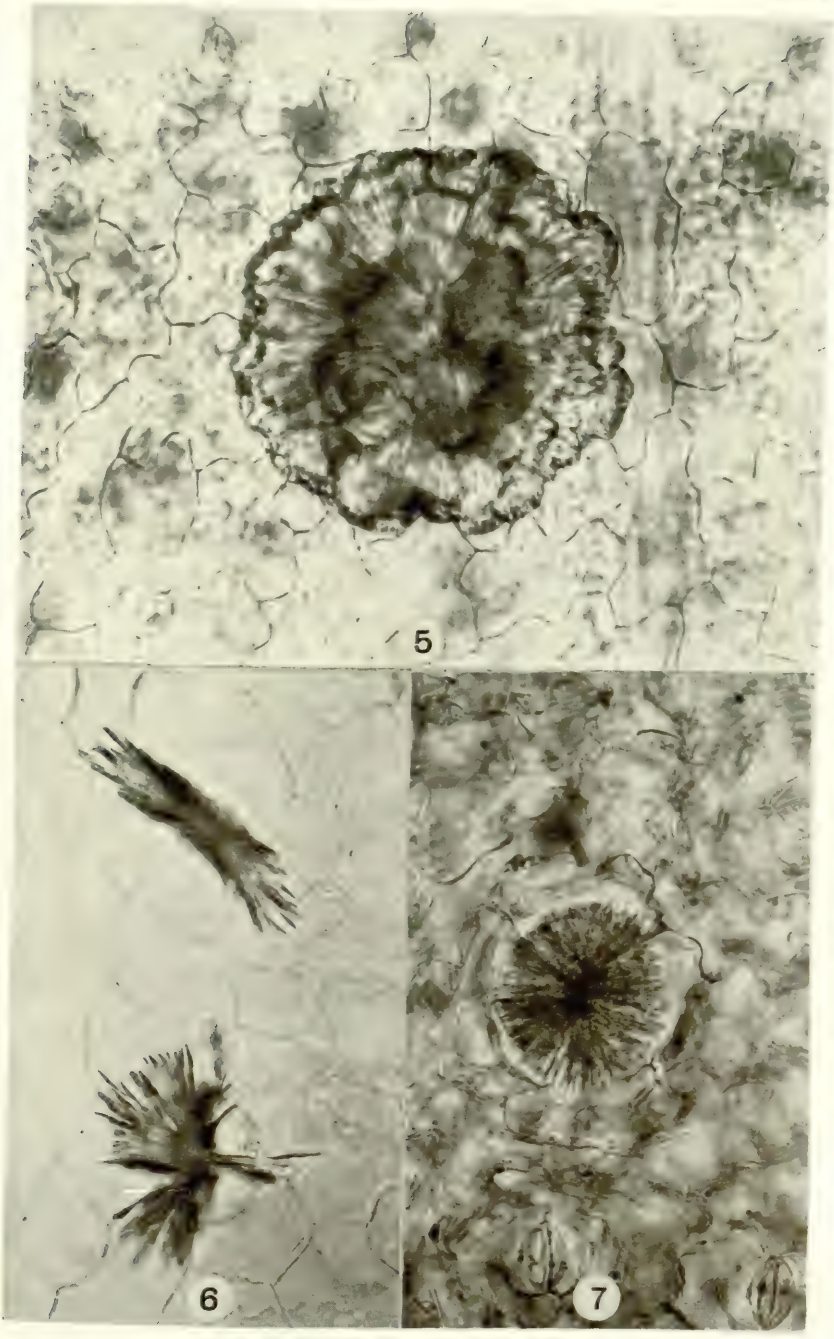
FIGS. 8 & 9. Large water-soluble birefringent bodies of *Pereskiopsis* (*Boke B-22*) preserved in FAA, photographed in polarized light, × 114; 8, crystals diffused throughout the body; 9, body having a cell at the center with birefringent contents, surrounded by an isotropic layer (except for druses of calcium oxalate persisting from the living leaf) and jacketed externally by a birefringent zone.

PLATE IV

FIGS. 10 & 11. Smaller more nearly spherical water-soluble birefringent bodies of *Pereskiopsis* photographed in optical section in polarized light. 10, From Boke's collection *B-20* preserved in FAA, × 330; 11, from Boke's collection *B-1* preserved in FAA, × 430.



BAILEY, LEAF-BEARING CACTACEAE, XIII



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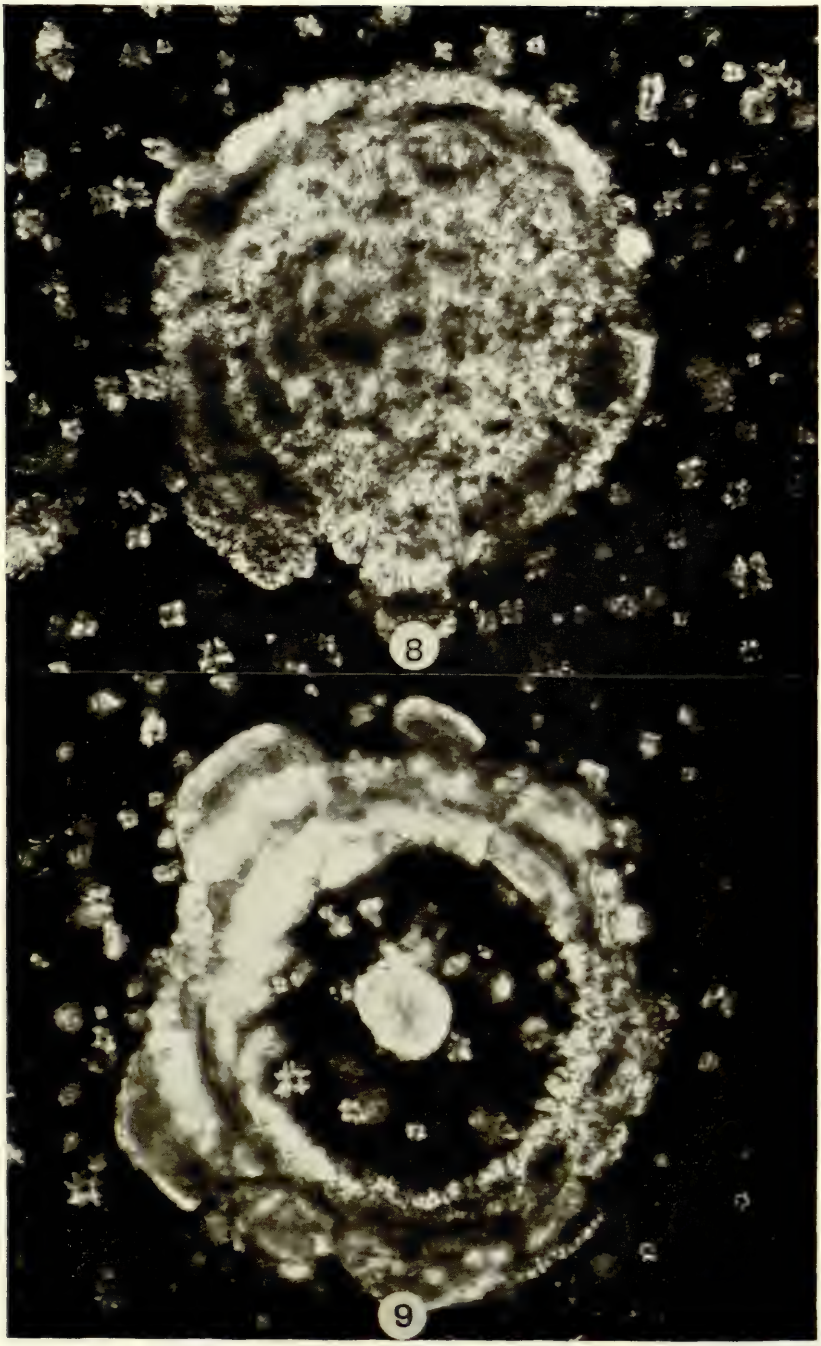

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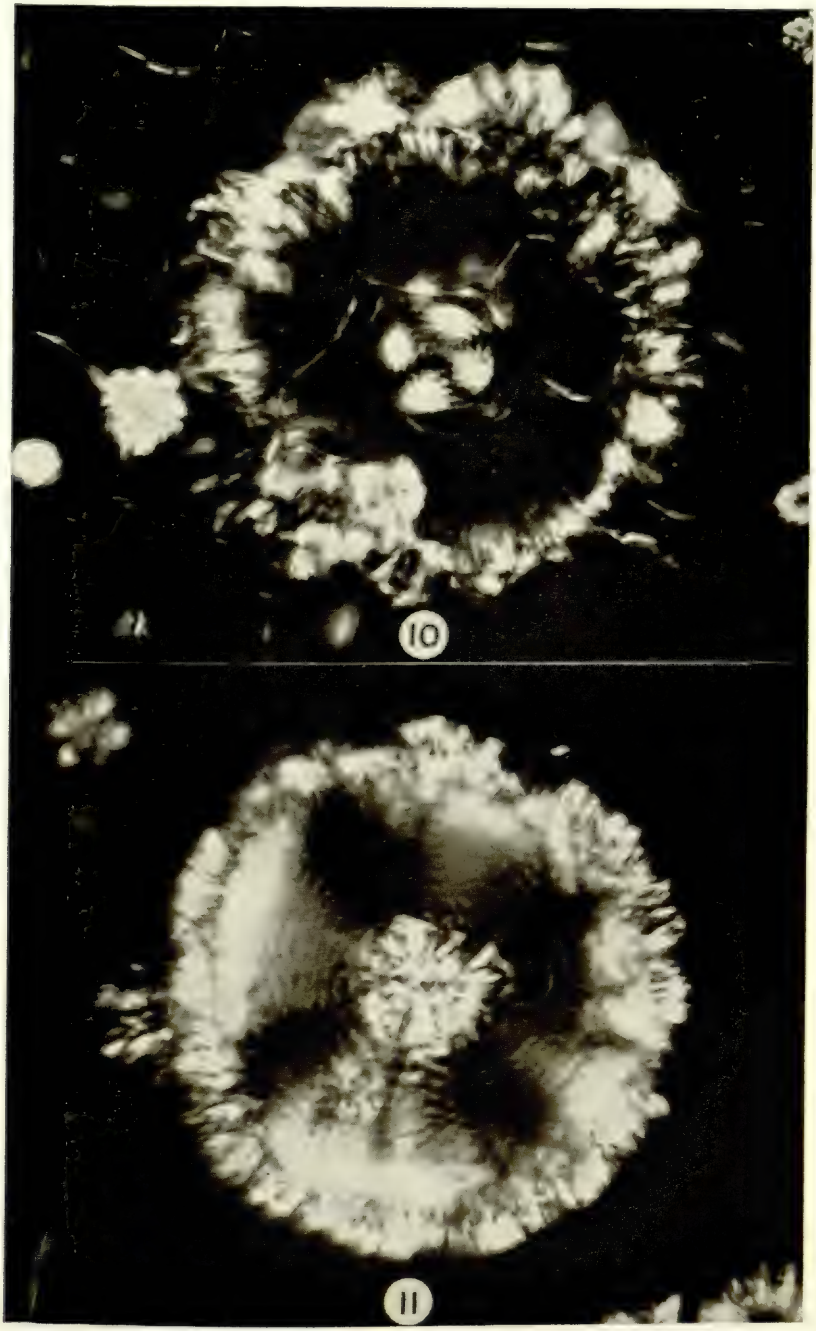


Bailey, Leaf-bearing Cactaceae, XIII

A NEW CUSCUTA FROM NEPAL

M. L. BANERJI AND SITESH DAS

DURING THE MONTHS OF SEPTEMBER AND OCTOBER, 1960, while the senior author was carrying on botanical exploration in East Nepal, a sizeable collection was made which included a conspicuous *Cuscuta* with reddish stem and dark brown flowers, parasitic on *Hypericum patulum*, *Banerji 1199*. On examination in the herbarium this plant did not agree well with any of the known species of *Cuscuta*. For identification of the material constant reference to the monograph of the genus by Yuncker (1932) and to Santapau and Patel's (1957) work on the Bombay Cuscutas has been made. Because of the presence of a single style on the gynoecium, very careful study has been made of *Cuscuta reflexa* Roxb., both of material in the Central National Herbarium, Calcutta, and of literature available in the Indian floras. By kindness of Dr. S. K. Mukerjee, Keeper of the Central National Herbarium, Calcutta, Wallich's and Hooker's sheets, mentioned by Yuncker (loc. cit.) under reference to *C. reflexa* Roxb., have also been examined, and flowers from these sheets have been dissected and studied. As the type of *C. reflexa* is not definitely known, Roxburgh's *Icones* have been referred to, as well as Van Ooststroom's treatment of the genus *Cuscuta* in *Flora Malesiana* (1955). Our conclusion is that the material collected from East Nepal is definitely not *C. reflexa* Roxb.

Amongst the Convolvulaceae collected by Zimmerman in 1954 in Nepal, very kindly sent by the Director, Conservatoire et Jardin Botaniques, Genève, to the senior author for determination, is a *Cuscuta, Zimmerman 1302*, which is exactly the same as *Banerji 1199*.

In the Central National Herbarium, Calcutta, is a sheet, *Burkill 35707*, from Dibrugarh (Assam) which, although named *Cuscuta reflexa* Roxb., is quite different from other sheets so determined. Further, this specimen of Burkill's superficially resembles the present materials from Nepal in characters of calyx, size of corolla, and position of the anther lobes. It is pertinent to mention that on this sheet (*Burkill 35707*) is a sketch of the characteristic globose-shaped gynoecium. A close examination of the flowers revealed a gynoecium with a prominent style 0.5–0.75 mm. long, in both the Nepal specimens and in Burkill's material. The infrastaminal appendages have also been found to differ from those of *C. reflexa* Roxb. A study of the pollen grains, made by the junior author, showed marked differences, too. Pollen from Wallich's and Hooker's materials has been found to measure 27.2μ, while the pollen from the Nepal materials measures 30.4μ in diameter in polar view. With such marked differences from *C. reflexa* Roxb., it seems best to treat these materials collected from East Nepal and Assam as a distinct new species.

Cuscuta santapaui Banerji & Das, sp. nov.

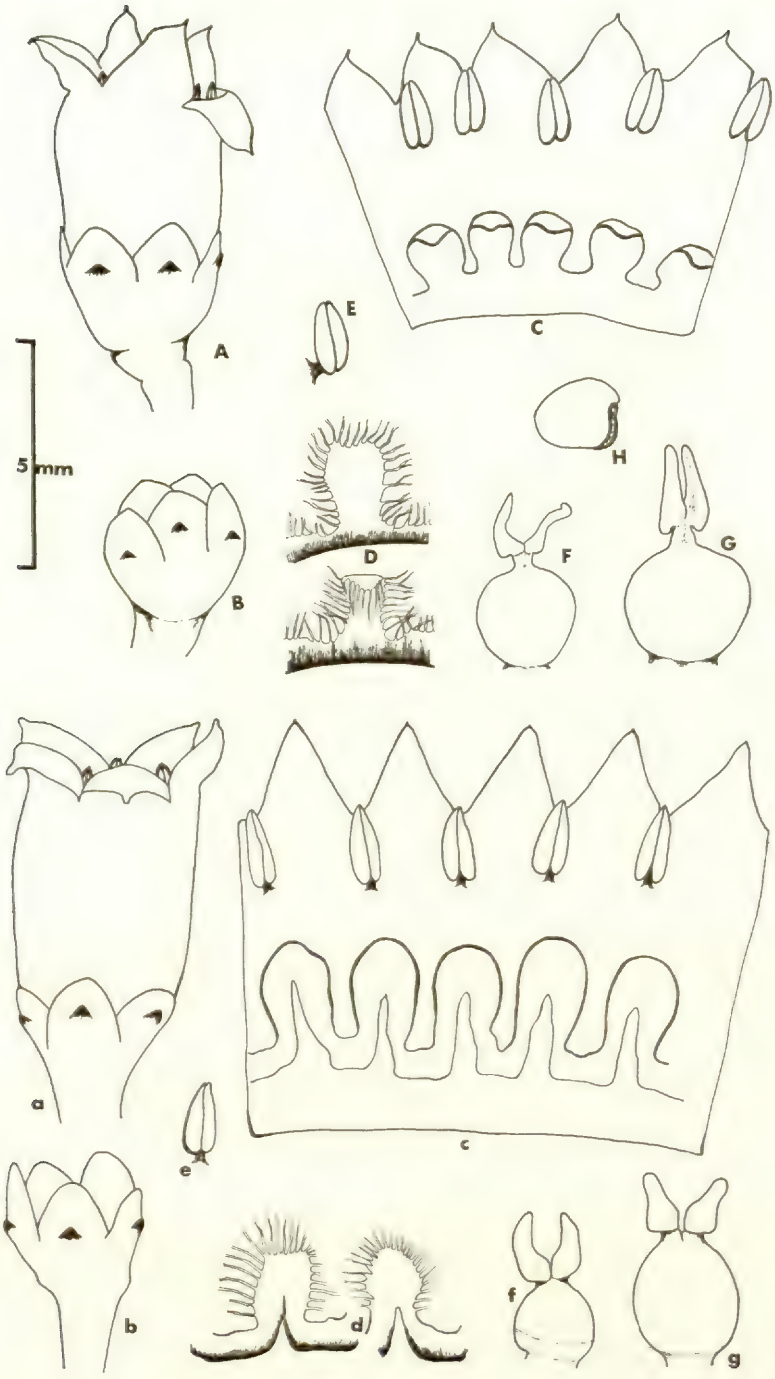
Caules sat crassi et asperi, rubreoli. *Flores* 6–7 mm. longi, breviter pedicellati, bracteati, in fasciculos cymosos paucifloros aggregati; pedicelli 1.5–1.75 mm. longi, bracteis minutis. *Calyx* cupulatus, plus minusve urceolatus, carnosus infra, membranaceus ad margines, laciniis alte divisis late deltoideis, 1.4–1.6 mm. latis, 1.25–1.5 mm. longis, altera alteri incumbenti, subaequalibus, externis quidem duabus minoribus. *Corolla* alba reticulationibus alte brunneis ornata, carnosa, ca. 5.5–6.5 mm. longa, cylindrica; corollae tubus 3–3.5 mm. diametro ad anthesim, laciniis late lanceolatis, 1.5–2 mm. longis, mucronatis ad apicem, patentibus. Appendices infrastaminales ad trientem tubi corollin longae, ex oblongis obovatae, in parte superiore incurvae, 2–2.5 mm. longae et 1 mm. latae; marginibus irregulariter fimbriatis, fimbriis etiam ad pontes visis. *Stamina* corollae lobis breviora; antherae integrae 1.25 mm. longae, 0.5 mm. latae; filamenta brevissima, dorsifixa. *Ovarium* globosum, vulgo 2.75–3 mm. diametro; stylus 1, crassus, 0.5–0.75 mm. longus, sulco uno indistincto per totam longitudinem insignitus, supportans stigmata bina linearia 1.5–1.75 mm. longa ad basin saccata. *Fructus* capsula circumscissilis; semina 4, paulum oblonga, singula ca. 0.5 mm. diametro.

HOLOTYPUS, *Banerji 1199*, lectus in via Nayapati ad Risingo in Nepalia ad altitudinem ca. 2500 m., positus in herbario Calcuttensi (CAL); ISOTYPI subeodem numero positi in herbario Arnold Arboretum (A), et in herbario universitatis Floridae australis (USF), in U. S. A., in herbario Bot. Surv. Nep. in Nepalia et in herbario universitatis Kalyanensis in India. Typi lecti sunt die 8 mensis octobris anni 1960 inficientes *Hypericum patulum*. Paratypus, *Burkill 35707*, ad Dibrugarh in Assamia lectus die 18 mensis novembris anni 1911 inficiens *Callicarpam* sp. positus in herbario Calcuttensi (CAL). Paratypus alter, *A. Zimmermann 1302*, lectus in Nepalia "de Simigaon au col." ad 2150 m. altitudinem, die 15 septembris 1954, et positus in herbario Hortus Botanici Genevensis (G) et in herbario universitatis Kalyanensis prope Calcuttam in India.

This new species of *Cuscuta* resembles *C. reflexa* Roxb. in general appearance, although differing markedly from it. The calyx is shallower and more or less urceolate; the corolla tube smaller; the infrastaminal appendages more deeply fimbriate and bearing fimbriae at the bridges. The ovary is globose with a clear or distinct style bearing two long and linear stigmas saccate at their bases; the seeds are minute. To contrast the characters of the new species with those of *C. reflexa* Roxb., illustrations of corresponding structures of the latter have been incorporated.

Yuncker (1932) has included only one species, *Cuscuta reflexa* and its var. *anguina*, in section Callianche of subgenus Monogyna. This new species, an addition to section Callianche, is named in honor of Rev. Fr. H. Santapau, now Director, Botanical Survey of India, who initiated the senior author in taxonomic studies and whose contributions in the field of taxonomy in India are enormous.

The authors thank Father Santapau for the Latin translation of the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diagnosis of the new taxon and Dr. S. K. Mukerjee for the facilities granted. The junior author is grateful to the University of Kalyani for the award of a scholarship during the tenure of which this work was carried out.

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Fig. 1. **Cuscuta.** A–H, *C. santapaui*: A, flower; B, calyx; C, interior of split and flattened corolla (infrastaminal scales have been shown in outline only); D, infrastaminal scales; E, stamen; F and G, gynoecia; H, seed. a–g, *C. reflexa*: a, flower; b, calyx; c, interior of split and flattened corolla (infrastaminal scales have been shown in outline only); d, infrastaminal scales; e, stamen; f and g, gynoecia. (All figures of *C. reflexa* drawn from Hooker's material.)

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THE GENERA OF POLYGONACEAE IN THE SOUTHEASTERN UNITED STATES [1]

SHIRLEY A. GRAHAM AND C. E. WOOD, JR.

POLYGONACEAE A. L. de Jussieu, Gen. Pl. 82. 1789, "Polygoneae," nom. cons.

(BUCKWHEAT FAMILY)

Annual or perennial herbs, shrubs, trees, or vines, often with conspicuously swollen nodes, the nodes completely or partly surrounded by a membranaceous or scarious sheath, the ocrea, or this reduced to a row of hairs or completely wanting in a few genera. Leaves entire [rarely pinnatifid or palmately cleft], alternate or whorled [or opposite], petiolate to sessile, membranaceous to fleshy or leathery, occasionally articulated at the base with the stem. Inflorescences diverse, the flowers seldom solitary, mostly clustered into few-flowered fascicles, each fascicle subtended by a bract and each flower by a persistent sheath (ocreola) and occasionally also by 2 scarious bractlets; rarely fascicles subtended by and partly included in an involucre, the flowers subtended at the base only by numerous bractlets. Flowers regular, with a variable number of parts, mostly 3- or 5-merous, bisexual or unisexual, the base (receptacle?) narrowed into a short or long stipe which articulates with the pedicel. Tepals (2–)5 or 6, in 2

[1] Prepared for a generic flora of the southeastern United States, a joint project of the Gray Herbarium and the Arnold Arboretum made possible through the support of George R. Cooley and the National Science Foundation and under the direction of Reed C. Rollins and Carroll E. Wood, Jr. The scheme follows that outlined at the beginning of the series (Jour. Arnold Arb. **39**: 296–346. 1958). The area covered in this, as in former treatments, is bounded by and includes North Carolina, Tennessee, Arkansas, and Louisiana. Material included in the descriptions in brackets applies to species outside this area, and references marked by an asterisk have not been seen by the authors.

Drs. Richard A. Howard and Ben W. Smith have reviewed the treatments of *Coccoloba* and of *Rumex* subg. *Acetosa*, respectively; their suggestions and corrections are gratefully acknowledged. Dr. Howard has generously allowed us to report two chromosome counts made by him; and Dr. R. B. Channell collected excellent flowering and fruiting material which has been indispensable in the study of *Brunnichia*. The illustrations were prepared by Arnold D. Clapman.

whorls, imbricate or quincuncial in bud, often petaloid, ± united, forming a short to long floral tube, persistent and sometimes enlarging in fruit. Stamens (3–)5–8 (9), inserted perigynously in 2 whorls, variously arranged but generally paired, occasionally alternating with nectariferous teeth and/or united into an annulus surrounding the ovary; filaments filiform, generally of two lengths, those opposite the internal whorl of tepals longest; anthers 2-locular, longitudinally dehiscent, versatile or basifixed; pollen of diverse types. Gynoecium (2–)3-carpellate, syncarpous; stigmata punctate, capitate, fimbriate, or flabelliform; styles 1–3, included to exserted; ovary 1, superior, lenticular or pyramidal, 1-locular, rarely incompletely 3-locular at base, sessile or slightly stalked; ovule 1, basal, on a short and thick or long and thin funiculus, orthotropous, the inner integument longer than the outer at anthesis and forming the micropyle. Fruit a lenticular or pyramidal (3-angled) achene, scarcely to entirely inclosed by the membranaceous tepals or the leathery or fleshy, accrescent floral tube. Embryo developing in the micropylar end of the seed, straight or curved, lying in one of the angles of the seed or along the middle of one side, outside of and curved around the abundant mealy or horny, sometimes ruminate endosperm or centered in it; perisperm wanting; radicle superior; cotyledons of diverse shapes. Embryo sac development normal (Polygonum type). TYPE GENUS: *Polygonum* L.

Predominantly of the North Temperate Zone, consisting of about 30 genera and 700 species; represented in the southeastern United States by seven genera. The family is a very natural and easily recognized one, but infrafamilial categories are much debated. At least five major classifications, none of which is entirely satisfactory, have been proposed (cf. Meissner, Bentham & Hooker, Dammer, Gross, and Jaretzky). The classification of Gross, which seems to be most in accord with the commonly accepted relationships of the genera, is followed here, although the subfamilial sequence is not considered by the writers to be an expression of the order of evolution within the family.

Two genera, *Fagopyrum* Mill. and *Emex* Campd., included in Small's *Manual of the Southeastern Flora*, are not known to be naturalized in the Southeast. *Fagopyrum esculentum* Moench (*F. sagittatum* Gilib., *Polygonum Fagopyrum* L.), buckwheat, $2n = 16$, grown extensively as a grain in Russia, is cultivated to a limited extent in the United States. Although escaping to roadsides and other disturbed areas, it probably does not persist for more than a season, at least in our area. The genus is included, however, in the key to genera because of its occurrence as a waif. The Mediterranean *Emex spinosa* (L.) Campd. is a waif evidently rarely introduced as seed in ballast but apparently not persistent in the Southeast.

Various authors have related the Polygonaceae to several families, including the Chenopodiaceae, Phytolaccaceae, Basellaceae, and Caryophyllaceae, mainly on the basis of the unilocular ovary and single basal ovule.

The family is now generally regarded as derived from and advanced over the Caryophyllaceae.

Floral anatomy of the Polygonaceae has been studied intensively. The most recent workers, Laubengayer and Vautier, agree that the basic floral plan is three-merous, with whorled parts, as in *Eriogonum* and *Rumex*, and that the five-merous condition, found, for example, in *Polygonum*, is derived. In five-merous flowers one tepal is bivalent, as shown by its position partly in and partly out of the two whorls of tepals and by its two vascular traces. (In some cases, the second trace may be reduced or missing, but the tepal generally remains intermediate in position between the two whorls.)

According to Laubengayer, the unilocular, uniovulate ovary was derived from a multiovulate gynoecium with free-central placentation by suppression of the lower portion of the ovary and by adnation of the lower part of the placenta to the lower ovary wall. The "funiculus" is, then, the remaining portion of the free-central placenta. Joshi, however, believes the ovule is borne on a true funiculus, with only the basal end of the stalk perhaps representing a vestige of a free-central placenta. (See Laubengayer and Vautier for summaries of the views of other authors on various aspects of the floral anatomy.)

The characteristic ocrea of the Polygonaceae has been interpreted variously as an outgrowth of the sheathing base of the petiole, as the product of the fusion of either a row of adjacent stipules or two lateral stipules, or as an expanded axillary stipule.

The pollen morphology is extremely diverse. The basic type from which others are thought to have been elaborated is ellipsoid, heavy- and smooth-walled, and has three long furrows, each with a central germ pore. It is found in such entomophilous genera as *Eriogonum*, *Fagopyrum*, and *Antigonon*, and in some insect-pollinated species of *Polygonum*. Evolution of the pollen grain is thought to have proceeded from this in two directions: in insect-pollinated species (such as *Polygonum Persicaria*), toward further elaboration of exine sculpture with concomitant reduction of furrows and increase in number of pores, and in wind-pollinated species toward reduction in number of pores and the thickness of exine, and loss of furrows.

The family is of minor economic importance, including a few food plants (e.g., *Fagopyrum*, *Rheum Rhaponticum* L.), some tropical timber trees, a number of ornamentals, and some noxious weeds. *Fagopyrum* was formerly the major commercial source of a flavonol, rutin, which strengthens capillary blood-vessel walls, preventing hemorrhage in victims of high blood pressure (cf. Couch, Humphreys).

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KEY TO THE GENERA OF POLYGONACEAE

General characteristics: *leaves mostly alternate and entire; nodes usually swollen and surrounded by a membranaceous sheath; flowers regular, the tepals forming a floral tube with the base narrowed into a stipe and articulated with the pedicel; ovary 1, superior, 1-locular, with a single basal orthotropous ovule; fruit a lenticular or 3-angled achene.*

A. Plants herbaceous or suffrutescent, occasionally (in *Polygonum*) twining climbing vines without tendrils.

B. Flowers subtended by and partly inclosed in an involucre; ocreae wanting; stamens 9. ..... 1. *Eriogonum*.

B. Flowers not involucrate, subtended by membranaceous ocreolae; ocreae present; stamens (3–)5–8 (9).

C. Tepals 6, the outer spreading or reflexed and remaining small in fruit, the inner erect, enlarging in fruit and often with conspicuous, raised venation or callosities. ..... 2. *Rumex.*

C. Tepals (2–)4 or 5 (6), all erect (the outer sometimes reflexed in fruit in *Polygonella*), without raised venation or callosities.

D. Tepals remaining small in fruit; achene pyramidal, exserted; embryo embedded in the endosperm; cotyledons convolute; flowers in small panicles, the upper appearing corymbiform. ..... [*Fagopyrum.*]

D. Tepals enlarging in fruit; achene lenticular or pyramidal, generally inclosed by the tepals; embryo in one angle of the achene outside the endosperm; cotyledons accumbent or incumbent, not convolute; flowers in panicles or spikelike racemes.

E. Branches nodal, not adnate to the internode; flowers 2 to several at a node in fascicles, the ocreolae imbricate, small and inconspicuous, scarcely unilaterally flared. ..... 3. *Polygonum.*

E. Branches appearing internodal due to adnation to the internode above the node of origin; flowers solitary at the nodes, in the axils of conspicuous, imbricated, unilaterally flared ocreolae. ..... 4. *Polygonella.*

A. Plants shrubs, small trees, or tendril-bearing vines.

F. Plants shrubs or small trees; leaves thick, leathery, reniform to orbicular; ocreae present; fruit an achene surrounded by a fleshy floral tube. ..... 5. *Coccoloba.*

F. Plants tendril-bearing vines; leaves membranaceous, ovate to deltoid; ocreae wanting or much reduced; fruit a 3–6-angled achene inclosed by membranaceous to leathery tepals.

G. Tepals rose-red, membranaceous; stipe remaining narrow in fruit; stigmata reniform-capitate. ..... 6. *Antigonon.*

G. Tepals yellow-green, leathery; stipe expanding in fruit to form a broad unilateral wing; stigmata irregularly flabelliform. ..... 7. *Brunnichia.*

Subfam. ERIOGONOIDEAE Meissn.

Tribe ERIOGONEAE [Dumort.]

1. **Eriogonum** Michaux, Fl. Bor.-Am. 1: 246. *pl. 24.* 1803.

Herbaceous, suffrutescent, or occasionally shrubby, bi- or triennials or perennials [or annuals] with large taproots, inhabiting open, dry, sandy or rocky regions; densely woolly [rarely glabrous]; branching di- or trichotomously; nodes lacking ocreae. Leaves basal in rosettes and cauline [or basal only], petiolate to sessile, the blade often decurrent on the petiole, the lower (abaxial) surface densely silver or brown tomentose. Basal leaves diverse in shape and size, in ours narrowly to broadly elliptic to oblanceolate; cauline leaves alternate, whorled [or opposite], narrowly to broadly elliptic, becoming bracts toward the top of the plant. Bracts foliaceous [or stipuliform], connate at base of involucre. Inflorescences

diverse, basically cymose; floriferous branches axillary and/or terminal; flowers subtended by and partly included within a turbinate [to cylindrical], 3–5(–8)-lobed involucre, the involucres solitary on the peduncle [or clustered]. Flowers 3-merous, the base narrowed into a long stipe [or this nearly wanting], bisexual, subtended at the base by numerous linear or lanceolate, scarious, setiferous to villous bractlets; flowers many [rarely 1] in an involucre, exserted at anthesis. Tepals 6, petaloid, white to yellow [or red], ovate to linear, erect or nearly so at anthesis, enlarging and remaining erect in fruit or the outer whorl becoming oriented at right angles to the pedicel and the inner remaining erect, covering the fruit. Stamens 9, two opposite each outer tepal and one opposite each inner tepal, persistent; filaments pilose at base, exserted [or included]; anthers versatile; pollen ellipsoid, tricolpate with long, tapering furrows, the exine thick, coarsely granular with 3 meridional strips between the furrows. Gynoecium 3-carpellate; stigmata 3, capitate; styles 3, filiform, long and exserted [or short and included]; ovary 3-angled, glabrous or villous. Fruit a 3-angled (or -winged?) ovate- or oblong-pyramidal, beaked achene. Embryo straight [or curved], centered [or excentric] in mealy endosperm; cotyledons thick, orbicular; radicle shorter [or longer] than cotyledons. TYPE SPECIES: *E. tomentosum* Michx. (Name from Greek, *erion,* wool, and *gonu*, knee, in reference to the tomentose pubescence and the geniculate nodes of some species.) — UMBRELLA-PLANT.

A North American genus of about 150 species in four subgenera and 14 sections, best developed in the western United States and well known for the taxonomic difficulties it presents. The four species occurring in the Southeast belong to subg. ERIOGONUM (subg. *Eueriogonum* S. Wats.),[2] comprised of perennials with turbinate involucres without angles or nerves and two to five or more foliaceous bracts, and sect. ERIOGONUM (§ *Eriantha* Benth.), having flowers with a stipelike base, achenes not winged, and embryo straight, centered in the endosperm.

Most widespread in the Southeast is *Eriogonum tomentosum* Michx., occurring from South Carolina to Florida along the sand hills of the inner part of the Coastal Plain. It is easily recognized by the dense, brown tomentum on the undersurface of the leaves and by the whorled cauline leaves. The three other southeastern species, *E. longifolium* Nutt., *E. Harperi* Goodman, and *E. floridanum* Small, have white pubescence and alternate cauline leaves. They and the eastern Texas *E. vespinum* Shinners

[2] It is not clear whether the names proposed by Watson (1877) were meant to be subgenera or sections. He refers to them as sections and indicates to which section the earlier names of Bentham (1856) and Torrey & Gray (1870) belong. The rank of Bentham's and Torrey & Gray's names also is unclear, being indicated only by the sectional sign (§), which was commonly used by the latter authors to indicate subgenera (see footnote 4 in Brizicky, Jour. Arnold Arb. **44**: 62. 1963). In a later work, Watson (1879) arranged the names in such a way as to suggest that his were of subgeneric and Torrey & Gray's of sectional rank. Bentham & Hooker considered Watson's names sections and Torrey & Gray's names series. Following recent authors (Coville & Morton, Munz & Keck, and Anderson), Watson's names are treated here as subgenera and Bentham's and Torrey & Gray's as sections.

are morphologically so similar that maintenance of four species is highly questionable, and a re-evaluation of their taxonomy is recommended. *Eriogonum longifolium* occurs in Texas, Oklahoma, Kansas, southern Missouri, and Arkansas, while *E. Harperi* is described as endemic to Colbert and Franklin counties in northwestern Alabama. Specimens examined from the area of Hot Springs, Arkansas, are difficult to place in either. *Eriogonum floridanum,* endemic to central peninsular Florida, differs from the preceding two species in having generally larger flowers, 6–10 mm. long *vs.* 4–8 mm. long, with very long pedicels (exceeding 1 cm.) in pedunculate, rather than nearly sessile, involucres. *Eriogonum vespinum* is distinguished from *E. longifolium* only in being less densely pubescent and having slightly longer peduncles and floral stipes.

Chromosome numbers, mostly undocumented, of several species of the western United States have been reported ($2n$ = 18, 22, 24, 32, 34, 40, and 80), the most common number being $2n = 40$. At least two western species, *Eriogonum fasciculatum* Benth. and *E. nudum* Dougl., include polyploid races of $2n = 40$ and 80. The basic gametic number is thought to be $x = 10$, with hybridization and aneuploid increases and decreases accounting for the wide range of numbers. Natural hybrids of several species are known or suspected, but production of artificial hybrids is hampered by the difficulty of emasculating the small flowers, each of which produces but a single seed.

The genus is considered to be closely related to the endemic American *Chorizanthe* R. Br. and *Oxytheca* Nutt., the only other members of the family with involucrate, nine-staminate flowers.

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Subfam. POLYGONOIDEAE [Meissn.]
Tribe RUMICEAE Dumort.

2. **Rumex** Linnaeus, Sp. Pl. 1: 333. 1753; Gen. Pl. ed. 5. 156. 1754.

Herbaceous annuals or perennials of open, generally disturbed habitats. Plants glabrous, with long taproots; ocreae scarious, cylindrical, the margins often becoming shredded with age. Leaves basal and cauline, entire, sometimes with crisped or undulate margins, membranaceous to subcoriaceous, long-petiolate, lanceolate [linear] to ovate, the base acute to obtuse or hastate, the apex acute; cauline leaves alternate, the upper ones reduced. Inflorescence composed of [a single terminal or] several axillary panicles, the flowers mostly 3 to several in an axillary fascicle at each node. Flowers 3-merous, green or reddish, bisexual or unisexual, the plants monoecious, polygamomonoecious, or dioecious; when monoecious the ♂ flowers borne above (distal to) the ♀ ones. Tepals 6, slightly united at base, forming a short floral tube which is narrowed into a long stipe shorter than to exceeding the pedicel; 3 outer tepals linear, reflexed and remaining small in fruit; 3 inner tepals ("valves") broadly ovate, erect and accrescent, inclosing the fruit, in some species developing raised reticulations and/or thickened callosities ("grains" or tubercles) on 1 or all 3 tepals, or with a prominent midvein on the outer (abaxial) side of each, the margins entire or variously toothed. Stamens 6, in pairs opposite the outer whorl of tepals; filaments short; anthers basifixed; pollen spheroidal, 18–32 μ in diameter, 3–6-colporate, the furrows long and narrow, variously arranged depending on the number present, the exine finely to coarsely reticulate. Gynoecium 3-carpellate; stigmata 3, fimbriate; styles 3; ovary 3-angled. Fruit a 3-angled, pyramidal achene. Seed coat smooth, shining. Embryo nearly straight, lying along the middle of one side of the achene; cotyledons linear to lanceolate, generally parallel or rarely perpendicular to wall of achene. (Including *Acetosa* Mill., *Acetosella* (Meissn.) Fourr.) LECTOTYPE SPECIES: *R. Patientia* L.; see Britton & Brown, Illus. Fl. No. U. S. ed. 2. 1: 653. 1913. (Name adopted by Linnaeus from ancient Latin.) — DOCK, SORREL.

A genus of over 100 species, world-wide in distribution, although poorly represented in tropical regions. About 50 species and hybrids are reported from North America, 11 of these introductions from Europe.

Thirteen to fifteen species in three of the four subgenera occur in the southeastern United States. Several species are widely distributed as noxious weeds of cultivated ground and roadsides.

Subgenus RUMEX (*subg. Lapathum* Pers.) is comprised of annuals and perennials, with leaf bases round to cuneate, never sagittate or hastate, flowers bisexual and inner tepals with or without callosities. The chromosomes are the smallest in the genus, $x = 10$, and $2n$ ranges from 20 to 200. Polyploidy and inter- and intraspecific hybridization have been reported in both sections of the subgenus.

In sect. RUMEX (§ *Simplices* Rech. f.), the single stem is unbranched with a terminal inflorescence. The six species of this section which occur in the southeastern United States are of European origin and are highly polymorphic, mostly with several subspecies. *Rumex crispus* L., $2n = 60$; *R. pulcher* L., $2n = 20$; and *R. obtusifolius* L., $2n = 40$ and 60, are widespread in the United States. Growing along roadsides and in waste places throughout our area, they are occasionally sympatric (e.g., in New Orleans, Louisiana; Tallahassee, Florida; and Granger and Hawkins counties, Tennessee). Putative natural hybrids of *R. crispus* × *R. obtusifolius* have been reported from Louisiana and of *R. crispus* × *R. pulcher* from Virginia. *Rumex crispus* in Great Britain is composed of several races, all evidently interfertile (Rechinger, 1961). Although widely distributed in the northern and western states, *R. conglomeratus* Murr., $2n = 20$, appears in our area only in the more easterly parts of North Carolina. Also common elsewhere in the United States but of limited distribution in the Southeast are *R. Patientia* L., $2n = 60$, known from scattered localities in Tennessee and North Carolina, and *R. maritimus* L. var. *fueginus* Dusén (confused by Small with *R. persicarioides* L.), $2n = 40$, reported from Little Rock, Arkansas. According to Rechinger (1937), *R. sanguineus*, $2n = 20$, is probably not present in the Southeast but has been confused by American taxonomists with *R. conglomeratus*.

Section AXILLARES Rech. f., characterized by plants with leafy axillary branches and secondary inflorescences, has its center of development in North America. Extra-American species are believed by Rechinger, on the basis of their isolated systematic position, to be relics of ancient lines of evolution. Seven species of this section have been collected in the Southeast, but *R. mexicanus* Meissn. and *R. cuneifolius* Campd., native to Mexico and South America, respectively, are known from limited material which suggests they are not established introductions. *Rumex verticillatus* L., $2n = 48$, 60, *R. floridanus* Meissn., and *R. fascicularis* Small, restricted to the Atlantic and Gulf coastal plains, are distinguished from one another on the basis of slight morphological differences which scarcely support specific rank. Also occurring on the Coastal Plain in Louisiana is *R. chrysocarpus* Moris (*R. Berlandieri* Meissn., *R. Langloisii* Small). *Rumex altissimus* Wood, $2n = 20$, widely distributed in the eastern and central United States, is known from most of the Southeastern States, generally occurring inland from the Coastal Plain. Several experi-

mental crosses made among species in the section (see Sarkar) show a high degree of pairing and good seed-set in the F_1 generation of the diploids, but completely sterile triploid and tetraploid hybrids.

Subgenus ACETOSA (Mill.) Reichenb., morphologically and cytologically the most variable subgenus, includes about 40 species in six sections, with a predominantly Old World distribution (most abundant in northern and eastern Africa, southern Europe, and the Middle East). The plants are shrubs or perennial or annual herbs and are hermaphroditic or dioecious, commonly with hastate or sagittate leaves, and inner tepals much longer than the achene and mostly without callosities. Chromosome numbers vary from $2n = 8$ to 40. The dioecious annual, *Rumex hastatulus* Baldw. ex Ell., $2n = 8$ ♀, 9 ♂, or $2n = 10$ ♀, 10 ♂, is the only member of sect. ACETOSA subsect. AMERICANAE Löve & Sarkar; its nearest relatives are the western American *R. paucifolius* Nutt. ex S. Wats. (§ *Paucifoliae* Löve & Sarkar) and the Old World *R. Acetosa* L. and *R. thyrsiflorus* Fingerh. (§ *Acetosa*), both with $2n = 14$ ♀, 15 ♂ and adventive in northeastern America. *Rumex hastatulus* is widespread in sandy soils of the Coastal Plain from North Carolina to northern Florida, west to Texas and Oklahoma, and occurs in the adjacent Piedmont on disturbed, well-drained sites.

Sex determination in *Rumex hastatulus, R. Acetosa*, and *R. paucifolius*, $2n = 14$ and 28, has been studied by several workers. An X/A balance mechanism of sex determination similar to that originally discovered in *Drosophila* occurs in *R. Acetosa*, with sex expression determined by the ratio of autosomes to X chromosomes, the Y chromosomes having no effect. Sex expression in *R. paucifolius* appears, on the other hand, to follow the more primitive X/Y scheme, discovered in *Silene* (*Melandrium*) and described later in *R. Acetosella*, in which strong male factors are located in the Y chromosome and the effects of the autosomes are secondary to the influence of XX *versus* XY.

Two karyologically distinct races differing in sex-chromosome morphology and chromosome number occur in *Rumex hastatulus*. The differences in karyotype have involved loss of one autosomal pair and the appearance of multiple Y chromosomes, changes which Smith has postulated to be the result of two successive translocations. Populations from North Carolina to Florida and Mississippi have a modified X/A mechanism ($2n = 6 + XX$ ♀ and $6 + XY_1Y_2$ ♂). Although sex is determined primarily by the ratio of X chromosomes to autosomes, the Y chromosomes are not entirely neutral but contain a region which enhances the expression of maleness. Populations from Louisiana and Texas to Oklahoma and Arkansas have ten chromosomes in both sexes ($2n = 8 + XX$ ♀ and $8 + XY$ ♂). The genetics of sex determination in this western race have not yet been analyzed.

Staminate plants of *Rumex hastatulus* are "heterogametic," producing male- and female-determining pollen in equal numbers; carpellate plants are "homogametic." In North Carolina, carpellate plants (57%) are more abundant than staminate (43%). Smith has suggested that the disparity in sex ratio in *R. hastatulus* may be attributable to a differential

selection favoring either the female-determining pollen or the female-determined embryos prior to the seedling stage, a phenomenon which has been demonstrated in *R. Acetosa* and in other dioecious plant species. Apogamy occurs in a few species of the subgenus but accounts for only an estimated 1–2% of seed-set.

Subgenus ACETOSELLA (Meissn.) Rech. f. consists of a polyploid series of perennial dioecious herbs with hastate or sagittate leaf bases and callus-free tepals which generally do not exceed the achene. One to four species are recognized, depending mainly on the emphasis placed on chromosome number. Löve (1944b), maintaining that "polyploidy alone seems to catapult a species into being," has recognized four species: *Rumex angiocarpus* Murb., $2n = 14$; *R. tenuifolius* (Wallr.) Á. Löve, $2n = 28$; *R. Acetosella* L., *sensu stricto*, $2n = 42$; and the arctic *R. graminifolius* Rudolph ex Lamb., $2n = 56$. The morphological distinctions between these are few, mostly quantitative, and tend to disappear when populations are studied over the entire range. Hexaploids ($2n = 42$) with the character of *R. angiocarpus* (tepals adnate to the fruit) have recently been found in populations from Europe, Canada, and Australia (Johnson & Briggs, p. 166). This complex, including Eurasian weeds of nearly cosmopolitan distribution, is represented in our area by diploid and hexaploid plants. Sex chromosomes are present, and the sex-determining mechanism is thought to be of the X/Y type. *Rumex Acetosella* is generally considered an indicator of acid, worn-out soils, but Artist, finding that the species grows on soils of pH 4.5–8.5, believes its distribution is probably dependent on a combination of several ecological factors, rather than on pH alone.

Pollination in *Rumex* is almost exclusively anemophilous, although insects occasionally are attracted by the red fruiting inflorescences. The fimbriate stigmata are well adapted to receiving air-borne pollen. *Rumex crispus* and *R. obtusifolius* are distinctly proterandrous; several other species are reportedly self-pollinated. Experimental crosses between subgenera have been unsuccessful.

Floral structure in *Rumex* is believed to have been derived by reduction from the basic three-merous type possessed by the closely related *Rheum*. Internal vascular bundles and internal phloem have been described from several species of *Rumex*, including *R. crispus*, *R. Patientia*, and *R. conglomeratus*. The perennial species without internal bundles are considered the oldest members of the genus.

The genus is of little economic importance. The leaves of some species are eaten as salad greens, the oxalic acid content imparting a slightly sour taste. Roots of *Rumex hymenosepalus* Torr., canaigre, contain up to 30% tannin and have been suggested as a commercial source of tannin. Some weedy species, such as *R. crispus*, are pests in cultivated areas, but can be controlled by cutting away the taproot to three inches below the soil surface, since regenerative capacity has been found lacking in the rest of the taproot (Healy).

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Tribe POLYGONEAE [Persicarieae Dumort.]

3. **Polygonum** Linnaeus, Sp. Pl. 1: 359. 1753; Gen. Pl. ed. 5. 170. 1754.

Annual or perennial herbs, shrubs, or twining vines of diverse, commonly moist habitats, often occurring as tenacious weeds in disturbed areas. Plants glabrous or pubescent; stems erect or prostrate, simple or branched, unarmed or with short recurved spines, the nodes often conspicuously swollen; ocreae completely or partly surrounding the nodes, cylindrical, membranaceous or scarious, often becoming hyaline with age, the distal margin entire, shredded, or bearing 1 to many short awns. Leaves basal and/or cauline, membranaceous [to ± fleshy], entire [rarely lyrate-pinnatifid or palmately cleft], alternate, sessile or petiolate, mostly linear to ovate, occasionally cordate, hastate, or sagittate, in some articulated with the stem. Inflorescence composed of axillary fascicles of 1 to several spirally arranged, pedicellate flowers; fascicles solitary in the axils of leaves or arranged into 1 or more terminal or axillary racemes (termed "spikes"), less commonly the racemes of fascicles paniculate [rarely the lower half of the inflorescence bulbil-bearing]. Flowers regular, green or white to pink or red, commonly 5-merous, bisexual or functionally unisexual, the stipe generally short, occasionally long; pedicel articulated with the flower, subtended by a scarious ocreola. Tepals (2–)4 or 5 (6), ± distinct, petaloid, erect, accrescent, completely or partly inclosing the achene, the outer ones smooth or keeled, rarely developing into broad wings in fruit. Stamens (3–)5–8 (9), the number and arrangement variable within each species, generally included, alternating with short, oblong, flattened nectariferous teeth, or the teeth lacking; anthers versatile; pollen of diverse types, some characterizing sections of the genus. Gynoecium (2–)3-carpellate; stigmata 2 or 3, punctate, capitate, or fimbriate; style 1 and deeply cleft or 2 or 3, included to exserted, straight and deciduous, or hooked at the apex, indurated and persistent; ovary lenticular or 3-angled. Fruit a lenticular or 3-angled pyramidal achene, both types occasionally occurring on the same plant. Seed coat smooth and shiny or rough and dull, light to dark brown. Embryo in one of the angles of the achene, outside of and curved around the abundant mealy or horny endosperm; cotyledons linear to lanceolate, accumbent or incumbent. (Including *Antenoron* Raf., *Bilderdykia* Dumort., *Bistorta* Mill., *Duravia* (S. Wats.) Greene, *Persicaria* Mill., *Pleuropteropyrum* Gross, *Pleuropterus* Turcz., *Reynoutria* Houtt., *Tiniaria* (Meissn.) Webb & Moq., and *Tracaulon* Raf.) LECTOTYPE SPECIES: *P. aviculare* L.; see Britton & Brown, Illus. Fl. No. U. S. ed. 2. 1: 659.

1913. (Name from ancient Greek, *polygonon,* an herb, from *poly,* many, and *gonu,* knee, the swollen nodes producing the appearance of jointed stems.) — KNOTWEED, SMARTWEED.

A highly variable and taxonomically difficult genus of about 150 species, nearly world wide in distribution and composed of several natural species-groups, the taxonomic ranks of which are much in dispute. In recent years data from cytology, palynology, floral anatomy, and chemistry have been used in an attempt to determine the relationships of the taxa and to devise a more natural classification. Unfortunately, emphasis often has been placed on one technique, without regard for existing information from other studies, thus leading to conflicting classifications. There is a need for correlation and careful weighing of all data in future studies of *Polygonum, sensu lato.*

The system followed here is, in general, modified from those of Steward, Steyermark, and Gleason. The infrageneric divisions, being based almost solely on variable vegetative characters, are considered sections of the genus. Thus defined, *Polygonum* is divided into eight sections, five of which occur in our area. Section TOVARA, distinguished from the rest of *Polygonum* mainly by its persistent, indurated, hooked styles, is considered by some taxonomists to be worthy of generic rank. However, to establish a genus in this family on the basis of a single character, even a floral one, is out of keeping with the magnitude of differences upon which the other genera of Polygonaceae are based. Section TINIARIA is considered to include sect. PLEUROPTERUS, since morphological distinctions between the two, though present in the species of our area, are lacking in several Asiatic species (e.g., *P. baldschuanicum* Regel, a woody vine with capitate stigmata but a much-branched paniculate inflorescence). Identical pollen morphology (see Hedberg), as well as chemical similarities (Jaretzky), support this union. *Fagopyrum* Mill., which differs from *Polygonum* in having nonaccrescent tepals, the embryo embedded in the endosperm, cotyledons rolled around the radicle, and more or less corymbiform inflorescences, is maintained as a distinct genus.

The pollen of *Polygonum* is of interest because of its unusual diversity; sectional limits within the genus are marked in several cases by distinct pollen types. Of additional interest is Doida's discovery that the number of pollen grains formed in each locule (microsporangium) is generally consistent for the species, a highly unusual phenomenon in the Angiospermae. In *P. Persicaria,* for example, the archesporial cell acts directly as the pollen mother-cell, dividing to form four microspores in each locule. Rarely it divides to form two pollen mother-cells, resulting in eight pollen grains. In *P. lapathifolium* and *P. sagittatum* there are eight pollen grains in each locule, and in *P. aviculare, P. Convolvulus,* and *P. orientale,* thirty-two. Other species have several pollen mother-cells, and the number of pollen grains may be 64, 128, or 256. Species with porate pollen have fewer grains per locule than those with colporate pollen. The number of pollen grains does not characterize sections.

Numerous chromosome counts have been made, but, unfortunately, many are unreliable due to questionable identifications and lack of voucher specimens. On the basis of all reported counts there seems to be no correlation between chromosome numbers and recognized sectional limits, wide ranges being found in each section.

Section POLYGONUM (§ *Polygonum* DC., § *Avicularia* Meissn., *Polygonum* L., *sensu stricto*; including *Duravia* (S. Wats.) Greene) is comprised of generally prostrate, much-branched annuals, with small leaves usually less than 2 cm. long and articulated at the base with the stem and flowers in axillary clusters. The pollen is spheroid-prolate, 3- or 4-colporate with furrows ½–⅘ the length of the polar axis, elliptic pores, and a smooth or granulate exine. Chromosome numbers of $2n = 20$, 22, 24, 40, 60, and 66 have been reported. Several widely distributed species of the section are present in our area, including the polymorphic *P. aviculare* L. (*P. neglectum* Bess., *P. buxiforme* Small), $2n = 20$, 22, 40, 60; the coastal American endemic *P. glaucum* Nutt., $2n = 20$, 40; *P. erectum* L., $2n = 40$; and *P. tenue* Michx., $2n = 20$. Equally widespread in the United States, but of more restricted occurrence in the Southeast (mainly in Louisiana, Arkansas, and Tennessee), are *P. ramosissimum* Michx., $2n = 20$; *P. prolificum* (Small) Robins., $2n = 60$; and *P. camporum* Meissn. The Asiatic *P. argyrocoleon* Steud. ex Kuntze has been collected as a waif on the outer banks of North Carolina.

The species of sect. POLYGONUM reportedly are inbreeding, the flowers being self-pollinated and perhaps also cleistogamous. In recent work on *P. aviculare* and related species, Styles has suggested that both hybridization and apomixis are rare, the extreme variability in morphology resulting from the influence of seasonal changes and of environmental factors in general.

Section PERSICARIA (Mill.) DC.[3] (*Persicaria* Mill.) includes plants of low, wet habitats and waste ground, with flowers in axillary or terminal spikes or racemes. The leaves are mainly elliptic to lanceolate and cauline, the tepals are neither keeled nor winged, and the branched stems are glabrous or pubescent, without recurved prickles. The pollen is spheroid, polyporate, with scattered circular pores and a reticulate exine. Reported chromosome numbers include $2n = 20$, 22, 24, 40, 44, 60, and 66. The section is the largest of the genus, with about 100 species. Of the 14 species in the Southeast, at least five are introductions from Europe or Asia: *Polygonum lapathifolium* L. (*Persicaria lapathifolia* (L.) S. F. Gray), $2n = 22$; *P. Persicaria* L. (*Pers. Persicaria* (L.) Small), $2n = 40$, 44; *P. Hydropiper* L. (*Pers. Hydropiper* (L.) Opiz), $2n = 20$, 22; *P. caespitosum* var. *longisetum* (De Bruyn) Steward; and *P. orientale* L. (*Pers. orientalis* (L.) Spach), $2n = 22$, 24. The last two occur only in the northern part of our area, while the other three are widespread. Species

[3] *Persicaria* was used by authors before De Candolle as an infrageneric category (e.g., see Linnaeus, Sp. Pl. 1: 360. 1753) but without clear indication of rank. De Candolle (Lamarck & De Candolle, Fl. Franç. ed. 3. 3: 365. 1805) appears to have been the first to apply the name without question to a section of *Polygonum*.

indigenous in our area are the variable, often aquatic *P. coccineum* Muhl. (*Pers. Muhlenbergii* (S. Wats.) Small); *P. densiflorum* Meissn. (*Pers. portoricensis* (Bert.) Small) and *P. hirsutum* Walt. (*Pers. hirsuta* (Walt.) Small), of the Atlantic coastal plain; and three highly variable species, *P. pensylvanicum* L. (*Pers. pensylvanica* (L.) Small), *P. hydropiperoides* Michx. (*Pers. opelousana* (Riddell) Small, *Pers. setaceum* (Baldwin) Small), and *P. punctatum* Ell. (*Pers. punctata* (Ell.) Small, *P. robustius* (Small) Fern.). *Polygonum bicorne* Raf. (*Pers. longistyla* (Small) Small) extends from the west into Louisiana, Arkansas, and Mississippi. *Polygonum mississippiense* Stanford (*Pers. mississippiensis* (Stanford) Small) has been described from Mississippi and *Persicaria paludicola* Small, 1933 (not *Pers. paludicola* (Makino) Nakai, 1926), from the Everglades, Florida. The northeastern *Polygonum Careyi* (*Pers. Careyi* (Olney) Greene), although included in Small's *Manual*, does not appear to extend southward into our area.

A number of species in sect. PERSICARIA have both terrestrial and aquatic forms (sometimes remarkably unlike) which can be changed from one to the other by merely changing the habitat. Such amphibious species are often sterile, spreading by means of rhizomes. Cleistogamy is reported in the section, and a tendency in the flowers toward separation of the sexes is apparent in some species, e.g., *P. hydropiperoides*. Several putative hybrids have been recorded between species of sect. PERSICARIA, especially in Europe (for a list of hybrids see G. Hegi, Illus. Fl. Mittel-Europa, ed. 2. 3: 396–400. 1958), but almost no controlled experimental studies have been made. Careful biometrical, ecological, and cytological studies are needed for a better understanding of the species limits in this, as in the other sections of *Polygonum*.

Section ECHINOCAULON Meissn. (*Tracaulon* Raf.) is closely related to and at times has been combined with sect. PERSICARIA, from which it differs mainly in the sagittate or hastate leaves, reflexed prickles on the angles of the stem, and reclining, creeping, or climbing habit. The pollen is indistinguishable from that of sect. PERSICARIA. Chromosome numbers of $2n = 20$, 22, 24, 40, 44, 60, and 66 have been reported for the section. Two species, *P. sagittatum* L. (*Tracaulon sagittatum* (L.) Small), with sagittate leaves, and *P. arifolium* (*T. arifolium* (L.) Raf.), with hastate leaves, occur in tidal marshes and other wet places in our area. The Brazilian *P. Meisnerianum* Cham. & Schlecht. var. *Beyrichianum* Meissn., easily recognized by its cordate, narrowly lanceolate leaves and dichotomously branched inflorescence with glandular hairs, was collected, probably as a waif, along the Tchefuncta (Chefuncte) River, St. Tammany Parish, Louisiana, in the late 1800's.

Section TOVARA (Adans.) Benth. & Hook.[4] (*Antenoron* Raf.[5]), com-

[4] Torrey (Fl. State N. Y. 2: 151. 1843), apparently, was the first to use *Tovara* as an infrageneric category of *Polygonum*, but without clear indication of rank. The first certain use of *Tovara* as a section of *Polygonum* appears to be that of Bentham & Hooker (Gen. Pl. 3: 98. 1880).

[5] If sect. TOVARA is recognized at the generic level, the name *Tovara* Adans. (Fam.

prised of one to three species disjunctly distributed in eastern America and eastern Asia, is distinguished by an elongate spikelike inflorescence, a 4-parted floral tube, and a persistent style, 2-parted to the base with recurved, hooked tips, which in fruit becomes very rigid and bent obliquely downward. According to Hedberg, the pollen is spheroid and 12-porate, with oblong pores arranged as though along the 12 edges of a cube; the exine is finely reticulate.

The eastern American *Polygonum virginianum* L. var. *virginianum* (*Antenoron virginianum* (L.) Roberty & Vautier, *Tovara virginiana* (L.) Raf.) is widely distributed in shady bottom lands and thickets, from Quebec to northern Florida, west to eastern Texas and Minnesota, with disjunct populations in central Mexico (Hidalgo and Puebla). A glabrous variety, *P. virginianum* var. *glaberrimum* (Fern.) Steyerm., was described from our southeastern coastal states. The eastern Asiatic members of this section have been considered as either two distinct species (*P. filiforme* Thunb. and *P. apoënse* Elmer) or three varieties of *P. virginianum*, depending on the emphasis placed on density of pubescence, shape and size of leaves, shape of base of leaves, and color of tepals. *Polygonum virginianum* var. *filiforme* (Thunb.) Nakai, distributed from southern Korea and Japan to southwestern China, has a reported chromosome number of $2n = 44$.

The dispersal mechanism of fruits in this group is unique in the family. During maturation of the fruit a separation layer forms across the pedicel, leaving only the vascular cylinder intact. When the fruits are mature, disturbance of the plant causes the vascular cylinder to break and the fruits to be catapulted forcibly as much as three or four meters. The origin of the catapulting force has not been satisfactorily explained in modern physiological terms (cf. Reed & Smoot). In addition to being thrown from the parent plant, the fruits, with their persistent hooked styles, may catch in the coats of animals, becoming dispersed over even greater areas.

Section TINIARIA Meissn. (including *Reynoutria* Houtt., 1777; *Bilderdykia* Dumort., 1827; *Tiniaria* (Meissn.) Webb & Moq., 1846; and *Pleuropterus* Turcz., 1848) is comprised of annual or perennial trailing or erect plants with axillary or terminal spikes or panicles. The tepals are keeled or winged, the stigmata capitate or fimbriate, and the pollen similar to that of sect. POLYGONUM, but with furrows generally more than $\frac{4}{5}$ the length of the polar axis and a smooth to finely reticulate exine. Chromosome numbers of $2n = 20$, 22, 40, 44, and ca. 88 have been reported for the section.

Three species occur in our area. *Polygonum Convolvulus* L. (*Bilderdy-*

Pl. 2: 276. 1763) cannot be used, since it has been rejected in favor of a later homonym, *Tovaria* Ruiz & Pav. (Prodr. 49. 1794; see Int. Code Bot. Nomencl. 263. 1961), of the Tovariaceae or Cruciferae. The later name is an orthographic variant of the earlier, both having been designated in honor of a 16th century Spanish physician, Simón a Tovar. *Tovara* is replaced by the next oldest legitimate generic name, *Antenoron* Raf. (Florula Ludov. 28. 1817; type species: *A. racemosum* Raf. = *A. virginianum* (L.) Roberty & Vautier).

kia Convolvulus (L.) Dumort.), $2n = 20$ and 40; *P. scandens* L. var. *scandens* (*B. scandens* (L.) Greene); and *P. scandens* var. *cristatum* (Engelm. & Gray) Gleason (*B. cristata* (Engelm. & Gray) Greene and *B. dumetorum* sensu Small), $2n = 20$, are widespread in the Southeast and beyond. *Polygonum cilinode* Michx. (*B. cilinodis* (Michx.) Greene), of the northeastern United States, reaches its southern limit in Tennessee and North Carolina. In addition, the Japanese *P. cuspidatum* Sieb. & Zucc. (*Pleuropterus Zuccarinii* Small, *Reynoutria japonica* Houtt.), $2n =$ 44 and ca. 88, and *P. sachalinense* F. Schmidt ex Maxim. (*Reynoutria sachalinensis* (Maxim.) Nakai), flowering bamboo, are often cultivated for their vigorous erect growth and showy panicles of flowers. Both species persist after cultivation and are very difficult to eradicate due to an extensive, spreading rhizome system. In the Northeast, escapes are becoming obnoxious weeds. Both species have been collected in Tennessee and North Carolina and may be expected elsewhere in our area in the future, if not controlled.

Extrafloral nectaries are found in several species of sect. TINIARIA (e.g., *P. Convolvulus* and *P. sachalinense*). They consist of a circular to oval depression at the base of the petiole on the abaxial side containing multicellular, short-stalked, glandular trichomes. Fully developed before the leaf unfolds, the nectaries are thought to function as hydathodes, providing a release for excess turgidity developed during formation of the leaf.

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4. **Polygonella** Michaux, Fl. Bor.-Am. **2**: 240. 1803.

Heather-like, subherbaceous annuals or suffrutescent perennials, mainly of sand hills, scrublands, and waste places. Branches many, erect, adnate to the parent stem for approximately half the length of the internode. Leaves alternate, narrowly linear to spathulate, caducous or persistent, sessile, articulated with and appearing to arise from the free upper edge of the membranaceous, cylindrical ocrea. Inflorescence racemose, terminal on primary and lateral branches, the flowers solitary in the axils of imbricated ocreolae and slightly to well exserted from them; ocreolae unilaterally flared to an acute or acuminate apex, the margin entire or bearing several short to long, bristle-like hairs. Flowers bisexual or functionally unisexual (the plants dioecious, gynodioecious, or gynomonoecious); pedicel broader and longer than the stipe and subtended by 2 lanceolate, keeled, scarious bractlets, or bractlets wanting. Tepals 5, slightly fused, forming a short floral tube, erect (the outer tepals occasionally tardily reflexed), in 2 whorls of 2 outer and 3 inner ones, or (in subg. *Thysanella*) 2 outer, 2 inner, and 1 transitional one, white to red, accrescent, the margins entire to fimbriate. Stamens 8, in 2 whorls; filaments mostly included, alike (subg. *Thysanella*) or the inner whorl of 3 dilated near the base forming 2 lateral nectariferous teeth (subg. *Polygonella*); anthers versatile; pollen prolate, 12–40μ long, tricolporate, the pores equatorially arranged, the furrows longitudinally elongated, the exine reticulate. Gynoecium 3-carpellate; stigmata 3, punctate; styles 3, filiform, free to the base; ovary 3-angled, slightly stalked. Fruit a shiny yellow to brown or gray pyramidal achene. Embryo straight, in one of the angles of the seed; cotyledons oblong, thick and fleshy; radicle equalling or exceeding

cotyledons. (Including *Delopyrum* Small, *Dentoceras* Small, and *Thysanella* A. Gray.) TYPE SPECIES: *P. parvifolia* Michx. = *P. polygama* (Vent.) Engelm. & Gray. (Name a diminutive of *Polygonum*.) — JOINTWEED.

Indigenous to the eastern United States, with two subgenera and nine species, all but *Polygonella Parksii* Cory (endemic to Atacosa and Wilson counties, Texas) occurring in the Southeast.

Subgenus THYSANELLA (A. Gray) Horton[6] (*Thysanella* A. Gray, *Polygonella* § *Thysanella* (Gray) Roberty & Vautier) has inner tepals fimbriate, filaments alike, and pedicels subtended by bractlets within the ocreolae. It consists of *Polygonella fimbriata* (Ell.) Horton var. *fimbriata* (*T. fimbriata* (Ell.) A. Gray), of Florida, Georgia, and Alabama, and var. *robusta* (Small) Horton (*T. robusta* Small), $2n = 32$, endemic to Florida.

Subgenus POLYGONELLA (§ *Delopyrum* (Small) Roberty & Vautier, § *Dentoceras* (Small) Roberty & Vautier), with inner tepals entire, the inner whorl of filaments dilated near the base, and pedicels not subtended by bracteoles within the ocreolae, composes the remainder of the genus. The species are distinguished by such characters as habit, type of margin on the ocreolae, number of ocreolae in a raceme, shape and size of leaves, and color and position of tepals during flowering and fruiting.

The procumbent, mat-forming *Polygonella myriophylla* (Small) Horton (*Dentoceras myriophylla* Small) is endemic to the southern part of the Florida lake region. *Polygonella ciliata* Meissn. var. *ciliata* and var. *basiramia* (Small) Horton (*Delopyrum ciliatum* (Meissn.) Small and *D. basiramia* Small), both $2n = 22$, are also restricted to Florida. *Polygonella macrophylla* Small, $2n = 28$, occurs on the Gulf Coast of Alabama and northern Florida. More widespread are *P. gracilis* (Nutt.) Meissn. (*Delopyrum gracile* (Nutt.) Small, *Delopyrum filiforme* Small), $2n = 22, 24$; *P. polygama* (Vent.) Engelm. & Gray (*P. brachystachya* Meissn., *P. Croomii* Chapm.), $2n = 28$; and *P. americana* (Fisch. & Mey.) Small. The first two are species of the Coastal Plain; the latter is generally piedmontane, occurring sporadically from South Carolina to central New Mexico. *Polygonella articulata* (L.) Meissn. (*Delopyrum articulatum* (L.) Small), $2n = 32$, is the only species of the genus in the northeastern United States, reaching its southern limit in northeastern North Carolina. It is regarded as the most primitive species of *Polygonella* by Horton, who also believes that the modern species of the genus evolved in Florida from an ancestral stock forced southward by Pleistocene glaciations.

Internodal branching characteristic of *Polygonella* is lacking in the rest of the family. The wood anatomy is characterized by a lack of parenchyma in annuals and by axile xylem parenchyma in perennials. Starch is stored in the xylem in an unusual cell type which resembles a

[6] The taxonomic treatment follows the recent revision of *Polygonella* by J. H. Horton. We have also relied on this paper for much of the general information concerning the genus.

fiber in shape and pitting, but is nucleate and living at maturity. The floral anatomy is, by reduction, the simplest in the family (Vautier). Each tepal has a single trace which connects with the main vascular supply; the other floral parts are supplied by single free traces which end in the floral tube. No anatomical evidence of a double trace to the fused inner and outer tepal can be seen in this genus. Reported chromosome numbers form an aneuploid series ($2n = 22, 24, 28, 32$).

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Subfam. COCCOLOBOIDEAE Dammer

Tribe COCCOLOBEAE [Dumort.]

5. **Coccoloba** P. Browne ex Linnaeus, Syst. Nat. ed. 10. 997, 1007, 1367. 1759, nom. cons.

Dioecious shrubs or trees [vines] of warm sandy coasts and hammocks; nodes often swollen or geniculate. Leaves evergreen [or deciduous], thick and leathery [or membranaceous], alternate, variable in size and shape, ours reniform to orbicular or oblong to elliptic with apex obtuse and base cordate to acute, the surfaces minutely punctate [or the upper surface pitted and lower with superficial or sunken glands]; petioles short, attached to the stem near the base of [or well above] the partly deciduous tubular ocrea. Inflorescence a many- to few-flowered raceme [spike or panicle], less than to exceeding the leaves, terminal on primary and lateral branches. Flowers regular, greenish or yellowish white, unisexual or functionally so, campanulate, with a short floral tube, the stipe mostly equal to or shorter than the pedicel, the young buds completely covered by the ocreola which ruptures as they mature; pedicels [less than to] exceeding the length of the ocreola. Staminate flowers in 2–5-flowered, bracteate fascicles at the nodes, each flower subtended and surrounded by the persistent ocreola which incloses the adjacent flower and its ocreola, additional ocreolae of aborted flowers occasionally also present, the filaments long, exserted, the styles short, included. Carpellate flowers solitary at the nodes, subtended by a bract and surrounded by an ocreola, the filaments short, the anthers sterile, the styles long, exserted. Tepals 5, greenish white. Stamens (7) 8; filaments broadest at base and united into an annulus surrounding the ovary, without nectariferous teeth; anthers versatile; pollen prolate, ca. $50 \times 40\mu$, tricolporate, the furrows extending nearly to the apices of the grain, the pores slightly elongated equatorially, the exine finely reticulate, tectate-perforate. Gynoecium 3-carpellate; styles 3, the dilated apices stigmatic; ovary 1-locular, some-

times incompletely 3-locular at base; ovule on a long funiculus. Fruit an achene with 3 major ridges, surrounded by the fleshy floral tube, the tube persistent, accrescent, rose-purple to nearly black when mature, the lobes covering the apex of the achene [or the lobes alone accrescent, surrounding the achene]; seed filling the upper part of achene, the lower part with spongy tissue. Embryo straight, the radicle short, the cotyledons orbicular; endosperm ruminate. (*Coccolobis* P. Browne, Civ. Nat. Hist. Jamaica 209. 1756, invalidly published; *Guaiabara* Mill. Gard. Dict. Abr. ed. 4. 1754, nom. rejic.) LECTOTYPE SPECIES: *C. Uvifera* (L.) L. (*Polygonum Uvifera* L.), typ. cons. (Name from Greek, *coccos*, berry, and *lobos*, lobed, in reference to the fleshy, lobed floral tube surrounding the fruit.)

An indigenous tropical and subtropical American genus of about 170 species and one of the few tropical genera in the family. The greatest number of species (about 85) occurs in South America (about 44 in Brazil); two reach their northern limit in peninsular Florida. The sea grape, *Coccoloba Uvifera*, $2n = 132$,[7] a characteristic shrub or small tree of warm, sandy shores from Florida to northern Argentina, is immediately recognizable by its large orbicular to reniform leaves and the dense clusters of sweet-acid, rose-purple fruits (nearly black when fully mature). The pigeon plum, *C. diversifolia* Jacq. (*C. laurifolia* Jacq., *C. floridana* Meissn.), $2n = 22$, a tree to about 20 m. tall, with generally smaller, oblong to elliptic leaves and nearly black fruits, inhabits hammocks and scrublands in Florida, the Bahamas, the Greater Antilles, and Antigua. Both range along the east coast of Florida north approximately to Merritt Island; on the west coast *C. Uvifera* occurs at least as far north as Manatee County, but *C. diversifolia* is restricted to the southern counties. Hybrids of the two are known from Everglades National Park, Florida, and Prov. Pinar del Río, Cuba. *Coccoloba Uvifera* also hybridizes with several other species elsewhere in its range.

The taxonomy of the genus presents numerous difficulties. Many species have at least two names, one based on a staminate, the other on a carpellate plant, the unisexual condition having been discovered only recently (cf. Howard, 1949). Morphologically, the flowers vary little among species, while vegetative characters which, for lack of floral differences, must be used in classification, are extremely variable. In collecting *Cocco-*

[7] Previously unreported chromosome counts by Prof. R. A. Howard, Arnold Arboretum: *Coccoloba Uvifera* ♂, $2n = 132$ (meiotic count), *R. A. & E. S. Howard 10211*, Miami Beach, Dade County, Florida, 18 May 1948 (NY); *C. diversifolia*, $2n = 22$, seedling grown in Cambridge, Mass., from fruits of *R. A. & E. S. Howard 8976*, Arroyo del Oro, Prov. San Juan, Dominican Republic, 15 Sept. 1946 (GH).

An earlier count of $2n =$ ca. 80 for *Coccoloba Uvifera* (Edman, Acta Horti Berg. **9**: 270. 1929) is open to question, for it is possible that this was obtained from either hybrid or apomictic material of *C. Uvifera*. Since the name *C. diversifolia* has been applied incorrectly to several different species, Jaretzky's count of $2n =$ ca. 200 (Jahrb. Wiss. Bot. **69**: 441. 1928) may have been obtained from another species. Apparently both reports are undocumented by herbarium specimens.

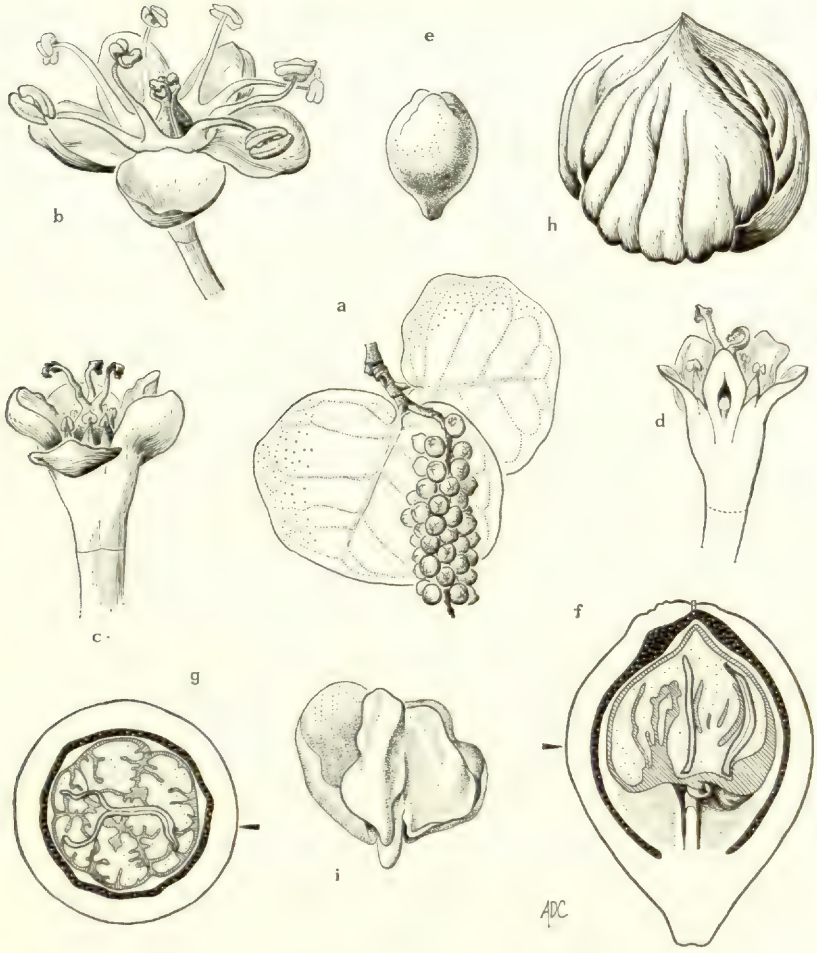

FIG. 1. **Coccoloba.** a–i. *C. Uvifera*: a, fruiting branchlet, × ¼; b, staminate flower, × 6; c, carpellate flower with staminodia, × 6; d, carpellate flower in semidiagrammatic vertical section to show floral tube and basal orthotropous ovule, × 6; e, nearly mature fruit completely inclosed by accrescent perianth, × 1; f, fruit in semidiagrammatic vertical section at level marked beside "g," showing accrescent perianth (unshaded), stony wall of achene (black with white stipples) with persistent style arm, spongy tissue below seed (fine shading) transitional to denser tissue (unshaded) surrounding seed, seed on stout funiculus, seed coat (hatched) penetrating endosperm (coarsely stippled) — note seed cut off-center, cotyledons appearing in section, two to right, one to left (cf. "g"), × 3; g, fruit in diagrammatic cross section at approximate level marked beside "f," the embryo cut through cotyledons, the perianth, achene wall, spongy tissue, seed coat, and endosperm as in "f," × 3; h, seed, × 4; i, embryo, inverted from position in seed, × 4. In "b–d" note articulation of stipe with pedicel.

loba care should be taken to represent the diversity of growth habit and leaf variability within the population. Adventitious shoots, which tend to have longer internodes and larger leaves than the normal stems, should also be included. Since the fruit of many species changes in shape as it matures, comparisons of size and shape can be made only with fully mature fruits.

A successful ornamental, *Coccoloba Uvifera* is planted along seasides in warmer regions of the world for its hardiness and attractive fruiting racemes and evergreen foliage. It has been reported in cultivation since 1690 and has become naturalized in several places in southeastern Asia and on some Pacific islands. Two variegated leaf forms are propagated. It is successful also as a pot plant, requiring little care except pruning. Jelly is sometimes made from the fruit. *Coccoloba diversifolia*, with bronze-colored juvenile leaves, is planted as a street tree in southernmost Florida. Both species are considered good honey plants, and birds feed on the fleshy fruits. Little work has been done on the biology of the genus, although hybridization apparently is frequent, and apomixis is suspected. Fossil leaves of *Coccoloba* are known from the Paleocene or Eocene of Alaska and also have been reported from Alabama, Mississippi, Texas, Arkansas, Louisiana, Tennessee, Kentucky, and Wyoming.

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6. **Antigonon** Endlicher, Gen. Pl. 310. 1837.

Herbaceous to woody, perennial vines; stems lightly to densely pubescent, often with geniculate nodes; lateral branches leafy or modified as tendrils; ocreae short, with a nearly entire margin, membranaceous and falling away on old stems or reduced to a fine line; axillary buds 2, one forming a lateral branch, the other an inflorescence, one or both sometimes suppressed. Leaves deltoid to cordate or hastate, the blades in ours not decurrent on the petiole. Inflorescence of terminal and axillary racemes bearing lateral tendrils, especially on their distal portions, and terminating in a forked tendril; flowers borne at the nodes, 3–5 in a fascicle, the fascicles subtended by an acuminate bract and each flower subtended by a membranaceous, persistent ocreola. Flowers bisexual, pedicellate, the pedicel persistent, the stipe and pedicel nearly equal in length. Tepals 5, forming a short floral tube, bright rose-red [purplish red or greenish white to yellow], persistent, inconspicuous in flower, accrescent, enlarging 3 or 4 times, inclosing the fruit, and often becoming very showy, the outer tepals cordate to ovate, the inner oblong. Stamens 8 (7–9), the filaments bearing scattered glandular-capitate hairs and alternating with small triangular, nectariferous teeth, the filaments and teeth united half their length to form a broad cuplike annulus around the ovary, the base of the annulus fleshy; anthers versatile; pollen subprolate, ca. 50 × 40μ, tricolporate, the furrows extending nearly to the apices and with the membranes lightly flecked with scattered granules, the pores elongated equatorially, the exine thick, finely reticulate. Gynoecium 3-carpellate; stigmata 3, reniform-capitate; styles 3, filiform, generally included; ovary 3-angled, slightly stalked, surrounded by the fleshy base of the annulus; ovule on a long, thin funiculus. Fruit a 3-angled achene. Seed with mealy, ruminate endosperm; embryo slightly excentric. (*Corculum* Stuntz, U. S. Dep. Agr. Bur. Pl. Indus. Bull. **282**: 86. 1913.) LECTOTYPE SPECIES: *A. leptopus* Hook. & Arn.; see Hooker & Arnott, Bot. Capt. Beechey's Voy. 308. *pl. 69*. 1840, and Britton & Wilson *in* Sci. Surv. Porto Rico Virgin Is. **5**: 265. 1924. (Name from Greek, probably from *anti*, similar to, and *gonu*, knee, alluding to the geniculate nodes; cf. *Polygonum*.) — CORAL-VINE, MOUNTAIN-ROSE.

A Central American genus of two or three species: *Antigonon guatimalense* Meissn. (*A. macrocarpum* Britt. & Small); *A. flavescens* S. Wats., perhaps only a greenish-white color form of *A. leptopus*; and the well-known *A. leptopus* (*Corculum leptopus* (Hook. & Arn.) Stuntz), Confederate vine, $2n = 40$, ca. 44, 48, a widely cultivated ornamental vine with cordate to hastate leaves and showy racemes of accrescent rose-colored flowers. *Antigonon leptopus* is planted throughout the warmer parts of

the Southeast and apparently has become naturalized in several scattered localities in Florida. Its natural range is described as Baja California and Chihuahua, south to Oaxaca, Mexico. In Florida the plant blooms continuously from early spring to late fall and may reach a height of 10 m., climbing by means of tendrils. Abundant viable seeds and edible tubers are produced, from which new plants sprout in the spring. The genus is insect pollinated, as the brightly colored tepals and copious nectar indicate. A white-flowered form (= *A. flavescens?*) is occasionally cultivated.

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7. **Brunnichia** Banks ex Gaertner, Fruct. Sem. Pl. 1: 213. *pl. 45, fig. 2.* 1788.

Perennial, woody, high-climbing, tendril-bearing vines of riverbanks and low damp ground, mostly growing in trees or thickets. Stems ridged [or nearly terete], glabrous or slightly pubescent; lateral branches short, ending in tendrils; axillary buds 2, one forming a lateral branch, the other suppressed or forming an inflorescence; ocreae short and entire, glabrous or pubescent, continuous with the base of the petiole or reduced to a row of hairs flanking each side of the base of the petiole. Leaves alternate, petiolate, ovate to oblong, the apex acute to acuminate, the base rounded to truncate. Inflorescence of densely flowered terminal and axillary panicles or racemes; flowers borne at the nodes, 3–5 in a fascicle, each fascicle subtended by a bract and each flower by a persistent, hyaline, lanceolate-subulate ocreola. Flowers bisexual, the stipe much longer than the short pedicel, the floral tube and stipe 3-ridged, with one ridge [or two] expanding in fruit to form a flattened, leathery wing. Tepals 5, whitish- or yellowish-green, oblong to elliptic, leathery, slightly united at base, forming a short floral tube, reflexed at anthesis, connivent in fruit, both tepals and pedicel accrescent. Stamens 8 (7–10); filaments exserted, persistent; anthers versatile; pollen subprolate, ca. 45 × 35μ, tricolporate, the furrows extending nearly to the apices of the grain, the pores slightly elongated equatorially, the exine thick, reticulate, tectate-perforate. Gynoecium 3-carpellate; stigmata 3, obscurely bilobed and irregularly flabelliform; styles 3, exserted, persistent; ovary 3-ridged; ovule basal in the spongy tissue of the locule, the funiculus long and

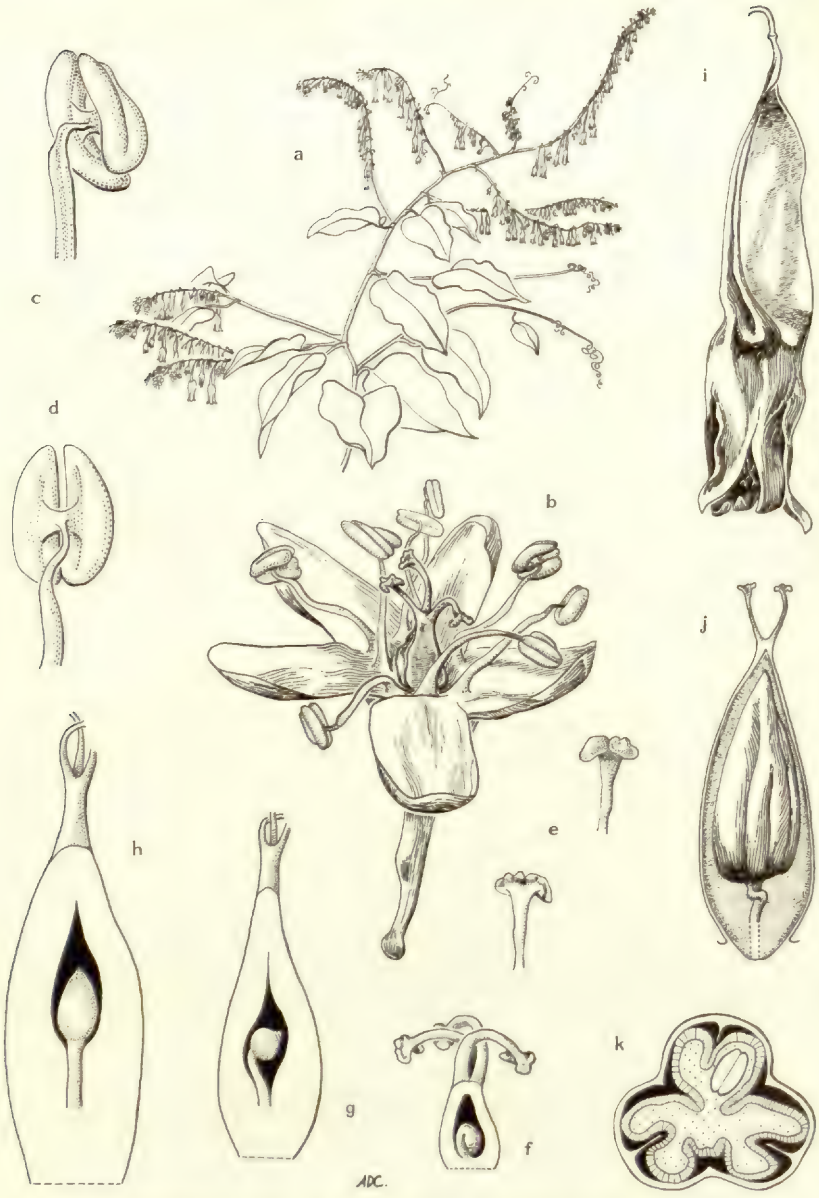

FIG. 2. **Brunnichia.** a–k, *B. cirrhosa*: a, flowering and fruiting branch, × ¼; b, flower disarticulated from pedicel, × 8; c, d, stamens, the anther-halves bent forward in "d" to show connective, × 16; e, two views of stigma, × 16; f–h, ovary in semidiagrammatic vertical section to show successive changes in orientation of ovule, beginning at anthesis — note incompletely developed outer integument of ovule, × 8; i, mature accrescent calyx with wing, the achene not visible, × 2; j, achene in semidiagrammatic vertical section to show seed sur-

thin, at anthesis anatropously bent so that the micropyle is directed downward, later straightening, the micropyle then directed upward (cf. FIG. 2).[8] Fruit a 3–6-angled achene inclosed in the persistent, accrescent floral tube; seed filling upper part of achene, spongy tissue the lower part. Embryo embedded in endosperm along one angle of achene; cotyledons oblong; endosperm mealy, ruminate. TYPE SPECIES: *B. cirrhosa* Gaertn. (Named for the Danish naturalist M. T. Brunnich, 1737–1827.) — EARDROPS, BUCKWHEAT VINE.

A genus of one American and two African species. The American *Brunnichia cirrhosa*, $2n = 48$, is found generally on rich bottom-land soils and along riverbanks of the south-central United States, from southern Illinois and Missouri, south to Texas and Louisiana, and is of sporadic occurrence eastward along the Coastal Plain to Florida and South Carolina. *Brunnichia erecta* Asch., ranging from Liberia to the Congo, and *B. africana* Welw., of Angola, have been segregated as *Afrobrunnichia* Hutch. & Dalz., primarily on the basis of the two- rather than one-winged pedicels.

The genus is most closely related to *Muehlenbeckia* Meissn. and is of no economic importance.

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[8] In a family characterized by orthotropous ovules, *Brunnichia cirrhosa* is remarkable in that the long, slender funiculus of the ovule is bent over at the apex, the micropyle thus facing the base of the locule. As Laubengayer (1937, p. 337) comments, however, it is essentially "still an orthotropous ovule, even though it does face in the opposite direction." As the ovary and ovule continue to develop after anthesis, the growth of the funiculus brings the ovule to an erect position, with the micropyle directed upward, as in other members of the family. The enlarging seed fills the upper part of the locule, while a spongy (flotation?) tissue occupies the remainder of the cavity. At maturity the seed has become so large that the funiculus is pushed downward, developing a crook or "kink" just beneath the seed. (Cf. FIG. 2, f–h, j.) Vautier (1949, p. 275) found a similar orientation of the ovule in *B. africana*, but thought that the ovule was at first orthotropous, later taking an anatropous position "which it does not seem, however, to keep up to the end of its development" (translation supplied). In *B. cirrhosa* the funiculus is anatropously bent long before anthesis, even in the very smallest buds which could be dissected.

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rounded by spongy tissue (stippled) filling fruit, × 4; k, diagrammatic cross section of fruit and seed cut through cotyledons of embryo (upper right), the endosperm stippled, the seed coat hatched, the space between seed and achene wall black — note three remnants of spongy tissue giving appearance of partial partitions, × 8.

LETTERS FROM CHARLES SPRAGUE SARGENT TO REGINALD SOMERS COCKS, 1908–1926 *

Edited by JOSEPH EWAN

82

May 6, 1915.

You sent us leaves of *Malus* from Sardis under three numbers — 1, 2 and 3. These appear to us, however, to be all the same thing and until I went to Selma I thought they might be a form of *Malus ioensis*, but I collected flowers on the road between Selma and Sardis which look very much like the flowers of *Malus platycarpa*. Now what we want is the fruit to make the determination certain. I suppose you can manage that this summer. I was surprised to find *Persea palustris* so common about Sardis as I did not know it ever got so far into the interior.

I had a letter from Palmer this morning in which he said things were coming out very rapidly and he thought *Tilia* would be in bloom in a week. I hope therefore you will bear in mind the collections of flowers at Lake Charles and Avery Island. Palmer says there are more different kinds of trees and shrubs about Natchitoches than any place he has yet visited, although *Crataegus* is not represented there by many groups.

How about the name for our Lake Charles *Carya*? I want to write the description and am depending on you for a very fancy and first-class name.

P.S. — There is a man here now preparing a monograph of *Smilax*, so if you have any doubtful specimens we had best see them. Your *Smilax* 91 from Wakefield, June 1907, is *Smilax lanceolata*.

83

May 12, 1915.

What is the *Tilia* situation? Of the three Lake Charles species we have flowers only of #2 and no fruit of 1, 2 and 3. Of the Sardis species which grows on the river bluff, your #6 of 1914, we have flowers and fruit. Of your other species (#1110) we have specimens only in very young bud, but a specimen of yours (no date and no number) is in flower; the label says "the neighborhood of Selma". This is the tree I found at Selma but did not see at Sardis where I suppose you did not see it. I hope you will be able to manage the fruit of this second species this summer. It certainly ought to be pretty fully grown before you return to New Orleans.

Pretty bad times these but there is no use thinking about them when there are trees to think of.

* Continued from volume 46, p. 44.

84

May 21, 1915.

I congratulate you on having found such a fine tree as *Magnolia acuminata* in Louisiana. I do not think it is surprising that it should be there but rather that it should have been overlooked so long. Please tell me the exact place where you found it, town if possible, so that I can enter it properly in my Manual.

This does not seem such a remarkable discovery as the finding by Harbison of *Magnolia* in northeastern Mississippi. He is finding a great many interesting things in that state and it would not surprise me if *Carya pallida* reaches eastern Louisiana as he finds it so abundant in western central Mississippi. You ought to make a special hunt for this in West Feliciana.

Carya callicoma I think sounds good and I am much obliged to you for the suggestion.

85

June 2, 1915.

I have written out the description of *C[arya] callicoma*. Your #15 from Natchitoches, with very young leaves, looks as if it might be this species. I do not suppose you remember much about it.

Is it possible that the Winnfield trees "in dry woods", that is near the quarry, with young leaves pale tomentose below, can also be *callicoma*? I think Winnfield needs more investigation as to its Hickories.

Your #1 Lake Charles, October 1913, is of course the same as your tree from the man's yard, and undoubtedly *C. arkansana*. There is fruit which probably belongs to this species collected "near English Bayou" where we did not see *C. arkansana*.

#11, 12 and 16 Natchitoches are *C. arkansana*, and #3 from Grand Ecore is probably the same.

I hope soon to hear from you about *Tilias*.

86

June 14, 1915.

I am glad to get your letter of the 10th of June which has arrived just as I was going to write to tell you that among some specimens of *Tilia* sent by Palmer are three numbers from Lake Charles and all apparently our #1. He seems to have missed the other two numbers, at least there is no trace of any pubescence whatever on these specimens. They were gathered too soon but among the lot there are one or two open flowers. I very much hope therefore you have been to Lake Charles and have got the flowers of our three numbers. I should judge that you might have been too early at Avery Island as I have received from a young lady there specimens of what she calls the smooth and rough-barked trees. The flowers, however, will answer our purpose after a fashion.

Is it possible that *Liriodendron* does not reach Louisiana? I have no record of it there and no specimen.

Can you tell me the range of *Quercus velutina* in Louisiana? While at Sardis you will look out, of course, for that peculiar *Quercus coccinea* with the deep cups. It will be interesting to know if this is a common form or only the peculiarity of an individual tree. I do not know what to say about that little Post Oak about Selma in which Harbison is so much interested. The leaves are very tomentose on the lower surface but I do not see that, except in habit, the shrub differs from the large trees in Selma. You have, I hope, the memorandum of the two Plums we found in flower near your place and south of Selma.

As I think I told you, I am trying to arrange the Hickories largely on the absence or presence of yellow scales on the leaves and on the involucre of the pistillate flower and fruit. I had supposed that these yellow scales did not occur on the pistillate flowers and young fruit of *Carya alba* until the other day when I received from Harbison specimens collected in Mississippi of what otherwise looked like *Carya alba*, but the young fruit was thickly covered with yellow scales. Such scales certainly do not occur on our tree as it grows here, and it is possible that the northern and southern trees ought to be separated. All this is preliminary to a request that you will look at *Carya alba* in the Selma region and see how the young fruit looks, and possibly dry me a few specimens, especially if you find the yellow scales.

Instead of going to North Carolina why don't you come to Brookline and do some work on the synonymy and bibliography of your Flora?

87

June 23, 1915.

I never received a more interesting package of plants from you than the one which arrived this morning — very many thanks.

Quercus 800 is surely Small's *Quercus austrina* which we have been hunting for so long and is evidently a good species. Would n't it be possible to get fruiting specimens?

802, *Quercus coccinea*. Is this the tree on the bank with the peculiar cups I wrote you about?

804, *Quercus nigra*. This is a distinct form with thicker leaves which are usually three-lobed at the apex. I saw a good deal of it between Selma and Sardis, and I think it ought to have a varietal name.

Tilia 788, Sardis, with leaves pale and glabrous below and prominent axillary tufts, seems to equal 2528, West Feliciana, and probably our 2 of Lake Charles. This I think is a common and widely distributed species in the southwest.

Tilia 784 and 786, leaves green and glabrous below, axillary tufts very small, looks like 2534 of Lake Charles.

780, 782, 790 and 792, the *Tilia* with leaves white pubescent below.

It would seem as if there were three and not two *Tilias* in the Selma-Sardis region as I had supposed. I only saw two last spring.

Acer 2520 seems to be a form of the Sugar Maple which is common in southern Georgia and in Mississippi. The leaves are paler on the lower

surface but I can see no other difference. We have never had flowers or fruit of this.

Quercus 2524, *pagodaefolia.*

Quercus 2526, *Q. alba.*

Tilia 2530, "#1, Lake Charles," on English Bayou at Miller Place. This has leaves densely pubescent below, but our #1 from Miller Place with checkered bark, collected April 12th, is perfectly glabrous.

Tilia 2536 is our #2 of April last.

Tilia 2534, bark like a Persim|m|on, is our #1, although you say #2?

I do not think we collected your 2530 at all. The pubescence is more rusty than that on the leaves of our #3. This new Lake Charles tree may be one of the Avery Island species. Did you find it on the Miller place?

You do not appear to have collected this time our #3 which has leaves white-pubescent below. The trees near the schoolhouse in West Lake Charles and the tree by the river bank in Lake Charles are our #3. This seems to be a common species and no doubt Palmer has the flowers.

Let me hear soon what else you are finding of interest at Sardis which seems to be an inexhaustible field.

88

June 28, 1915.

The *Ptelea* which we collected at Lake Charles in March 1911 looks exactly like the *Ptelea rhombifolia* of Heller and I think should be referred to that species, at least until we know more about the different forms of this troublesome genus. From eastern Louisiana I have one specimen of *P. trifoliata* collected by you but no other *Ptelea* at all from Louisiana. Have n't you met with the genus in other places in that state, and how does it happen that Selma and Sardis, which contain almost every other known plant, cannot boast of a *Ptelea*, at least there is nothing from that region in our herbarium?

89

July 2, 1915.

Very many thanks for the fruit of *Carya alba* which tells me just what I wanted to know. It is surprising that these yellow scales on the fruit of this species have always been overlooked. Perhaps, however, this is not more remarkable than that every American botanist has described the fruit of *Epigaea repens* as a dried capsule although it is really a fleshy berry.

There is no one now in this country who knows so little about *Tilias* as I do, but I should think Palmer could look after the fruit of the Lake Charles species this autumn. As you have read in my last letter, there is what appears to be a fourth species there. Undoubtedly the West Feliciana species are the same as those which grow at Natchez and I do not think you need to worry much more about them. This leaves Avery Island from which we certainly ought to have good fruiting specimens. I wrote to the

lady who sent the specimens the other day from there, asking her to send me a specimen of one of her numbers showing the young branches but I have had no answer from her. I have no more idea than you do when the fruit of these things ripen.

The Scarlet Oak which I want you to look into is a single tree growing on the edge of the bluff, or rather a little way back from the edge. We went from your place to a store, the post-office of Sardis I think, and then took the road to the river. We got out at a negro cabin near the river, walked across a field, and then turned to the left and followed along the cliff for some distance. This particular Oak cannot be more than three hundred yards from where we reached the bluff. The remarkable thing about this tree is the much swollen scales of the cup. If this sort of Scarlet Oak is common in the Sardis region, then it ought to be made a variety of *Quercus coccinea*. I think perhaps I had best send you one of the fruits we picked up under the tree. As you know, *Quercus rubra* also grows on this bluff, and very far south of any station I have known for it before.

How about the two Plum trees of which I wrote you? I hope you will follow them up, and also *Quercus austrina*. We should be glad to get specimens of any of the woody plants growing about Sardis which you may have time to make.

90

July 22, 1915.

You have n't said anything about having collected at the time of your last visit to Lake Charles fruiting specimens of that remarkable Ash tree with pendulous branches which we saw there. If you did not collect fruit I can ask Palmer to get it when he goes there this autumn. How early do you think the tree is likely to drop its fruit, and can you give any specific directions for finding the trees? We only saw one tree, as I remember, with fruit on it and that was hanging over a cottage close to the road. This of course was as we went down the lake (not towards the bayou) but I should not know what to tell Palmer in order to find this particular tree.

Anything new in the tree line at Sardis, and have you given up the idea of coming north this summer?

91

July 23, 1915.

How about the Slippery Elm, *Ulmus fulva*, in Louisiana? It is common from Missouri to Texas and it ought at least to be in western Louisiana, but I have no knowledge of it there.

92

July 29, 1915.

A new tree for the Selma region is *Carya carolinae-septentrionalis* which Harbison collected there this spring.

Why can't you send me now a specimen of the White Oak near your

place which we thought was *Quercus austrina*? I should like to see it in its present summer condition. It might be sent without drying I should think.

93

August 7, 1915.

I have your letter and the package of specimens, for both of which many thanks.

Acer 820 and 828 are *A. saccharum*. This form with leaves pale and pubescent below appears to be a rather common tree from southern Georgia and northern Florida to Mississippi. *Acer* 822 is *A. floridanum*.

Carya carolinae-septentrionalis is right. I have already written you that Harbison had found it near Selma.

Quercus 814 looks as if it might be a hybrid of *Q. imbricaria*. Do you know more than one tree? We ought to know more about it and get more material.

Quercus 812 Sardis must be *Q. Durandii*. Is this the small tree on the left-hand side of the road going from your house towards Sardis and at the foot of a rather steep hill where our motor got stuck? This was the tree we took for *Quercus austrina*. Please answer this. If your 812 is not our little tree, where does it grow? Have you noticed on 812 that the leaves on the lower branches are very different from those on the upper part of the tree?

Is your *Quercus* 800 the same as the 804 mentioned in your letter? 800 looks as if it might be the mysterious *Q. hybrida* of Chapman.

The *Tilia* cultivated at Lake Charles is *Tilia tomentosa* from Hungary.

I saw only two Lindens in the Selma-Sardis region but there are evidently three species, — 1st, the tree with leaves silvery pubescent below, your 780, 782, 790 and 792. 2nd, the tree with very coarsely serrate leaves, your 784 and 6 of July 1914. I did not find this tree and I do not know if the young leaves are all pubescent, and I am afraid that you do not. 3rd, the tree with leaves not so coarsely serrate as #2, covered below with pale stellate hairs in April and in June entirely glabrous with the exception of the conspicuous axillary tufts. This is your 788. 786 is the same but without the tufts. This was the only Linden I saw on the bluffs of the river at Sardis but I saw plenty of #1 south of Selma.

I think now, thanks to you, that we have complete material of these three Lindens. Can't you induce your friends at Avery Island to collect good fruiting specimens of Lindens there? There are probably two species, one a tree with pubescent branchlets and rusty pubescent leaves which are very scabrate above, your #6 of October 1910. I do not know that we have either flowers or fruit of this. It seems similar to the tree from the coast of Georgia which has passed for *T[ilia] pubescens*, but I daresay it is not that species. Two, a tree with leaves pale pubescent below and also rough above. This is Miss McIlhenny's smooth-barked Linden and your specimen of May 24, 1914. Can this be the same as #1? The difference in the time of year when the specimens were taken may account

for the different color of the pubescence. Miss McIlhenny's rough-barked Linden may be the same as #1 but the specimen is so poor that it does not tell much.

Palmer is now in St. Louis arranging his collection and I am afraid cannot get off much before the first of September, but I shall write him to get back to Louisiana as soon as possible. The Florida and Alabama Oaks seem to be as puzzling or more puzzling than the Lindens.

I wish you were here now for I am living all alone and we might get through a great deal of work together.

94

August 10, 1915.

I have received from you a box of Plum fruit but no word as to what it is. I suppose I should hear from you on this subject.

Your Wakefield, West Feliciana "Tilia americana," June 1907, is evidently the same as Selma #2, and the same as your specimen collected near Alexandria June 1905.

I cannot quite follow you on the Lake Charles *Tilia*. Your #2532 with pubescent branchlets and leaves pubescent below agrees with our #3 of last spring, but your #1 from the Mills' place (#2530) has the same pubescence as your number 3 (2532) although the branchlets are glabrous. Now unless there is a bad mixup on my part it is impossible that the tree in Mill's yard which had perfectly glabrous leaves on April 12th should on May 21st have leaves densely pubescent below.

I am writing Palmer today to get off as soon as possible and go first to Lake Charles for evidently there is no Linden at Natchitoches which does not also grow at Lake Charles. I hope you are hunting Oaks.

95

August 19, 1915.

Many thanks for your two notes and the information they contain. I hope you will continue to watch the Oaks at Sardis. You have said nothing about that peculiar form of *Quercus coccinea* about which I wrote you.

If the leaves of *Tilias* are going to change from glabrous to pubescent as they grow older I am afraid it will be hopeless to find characters by which they can be separated.

Too bad about Avery Island for I suppose the weather won't become cool there or mosquitos disappear until it is too late to collect Tilias.

I hope the cotton crop is going to be a success.

96

August 21, 1915.

I enclose a leaf of an Oak which Harbison found at Pleasant Hill, near Selma, and which may be an extreme form of *Quercus Durandii*. He found similar trees at other places near Selma, and I have asked him to write and give you as near as possible the locality of these trees in the hope that

you will be willing to investigate them before you leave Alabama and obtain mature specimens. According to Harbison Pleasant Hill is a very interesting place, and possibly you may like to visit it.

97

August 23, 1915.

Many thanks for yours of the 19th and for the Plums which have not yet arrived but which I suppose will be here tomorrow. It seems to me that this is about the worst of all the groups of our woody plants.

We are sending you by express to Tulane a set of woody plants collected in Louisiana by Palmer this year, or rather nearly a full set for I understand he has been obliged to leave some of them behind him at St. Louis in his pursuit of *Tilia* fruit. I will arrange that the herbaceous plants be sent from St. Louis.

I take no responsibility for Palmer's names, and a few of them appear to be incorrect. Notice his *Quercus* 7473 with leaves only from Natchitoches, which looks as if it might be *Q. Durandii*. His *Quercus* 7448 from Natchitoches seems to be the three-lobed form of *Q. nigra* common between Selma and Sardis. It needs a varietal name. His *Q. stellata* var. Grand Ecore 7518 and Chopin 7978 we are much interested in here. The pubescence seems to be like that of the Post Oak in Selma. I do not know if I wrote you about this tree and the importance of collecting fruit of it this autumn, as well as the little dwarf Oak in sandy soil near Selma which is evidently a dwarf form of the larger tree. Palmer makes a point that the bark of his tree is scaly like that of the White Oak and not rough like the Post Oak. Is this true of the Selma tree?

Palmer's *Quercus velutina* 7443 is stellate-pubescent on the upper surface of the leaves. This sort of pubescence so far as I have seen never occurs on the leaves of the straight *velutina* but is conspicuous on the variety *missouriensis* of mine from Missouri and Arkansas. On the Missouri tree, however, the branches are much more tomentose than Palmer's 7443, but in Mississippi and Florida there is a *velutina* without tomentose branches but with stellate pubescence on the upper surface of the leaves at least early in the season. This may be another variety. It has not yet turned up in Alabama and I hope you will be able to look at the *velutinas* in your region and see if you can find any trees with such stellate pubescence. Harbison claims that the trees in Mississippi with the stellate pubescence do not have the orange colored inner bark. This is a fact, however, which needs further investigation.

98

October 20, 1915.

Many thanks for your letter of October 15th. No, I have n't been ill but away on several short journeys this autumn and my correspondence has fallen into a hopeless condition of neglect. I was on the point of writing you when I heard of the storm in Louisiana but did not get around to it. I hope you did not suffer personal inconvenience, but I am afraid

many of our trees at Lake Charles were destroyed. I hope, however, the Hickories are all right.

Have you been out this autumn with Palmer? He wrote me that you thought of doing so. I have n't heard from him for some time and I fancy that he is now in eastern Texas or Oklahoma as he went early from Louisiana. I am sorry to say that he found that many of the Lindens from which he collected in the spring were blown down early in the summer.

Please let me hear from you soon.

99

November 1, 1915.

Many thanks for the collection of Oaks from the Selma district. The more I see of these Selma Oaks the less I know about them and this last collection of yours seems to me the worst lot I have seen.

904 is *Crataegus tomentosa*. The other specimen of *Crataegus* in fruit I do not know.

950. I do not know this Oak. Is it some form of the Water Oak? Do you remember the tree?

954. *Quercus velutina*.

972. *Quercus austrina*, if there is such a thing.

962 I suppose is the dwarf form of the new Post Oak with scaly bark. As you know, this also grows at Natchitoches.

934. Is this not the common Post Oak? It shows none of the pubescence which is so conspicuous on the under surface of the leaves of the new Post Oak. How is the bark of this 934?

952, 968, 960 and 932 seem to be *Q. Durandii*.

930. Is this *Q. austrina* again?

938 looks as if it might be a hybrid of *Q. imbricaria*. It is unknown to me.

956 is the new Post Oak.

958 is nearly glabrous and I suppose is the common Post Oak.

I am going to take up the Oak question seriously when Harbison's collection of the past autumn arrives and try and come to some conclusion about some of these troublesome southern species, varieties or hybrids. It is rather curious that this scaly barked Post Oak grows at Selma and then not again until we get to Natchitoches. By the way, Palmer writes that he thinks he has found *Gleditsia texana* at Natchitoches. This would be a new tree for Louisiana. Apparently anything can be expected in the Natchitoches region.

I hope you are all right.

100

November 12, 1915.

We have been able to raise two new Chinese *Citrus* plants which may prove useful. The first of these, *Citrus ichangensis*,[10] has fruit something

[10] Burkill includes this in *C. macroptera*, as a race of thick-skinned shaddock-like *Citrus*.

like a grapefruit although rather smaller. Some persons think that the fruit has even a better flavor than that of grapefruit but this of course is doubtful. The great point about it is that it is likely to be much hardier than the grapefruit or any other *Citrus* plant with edible fruit. The fact that our plants are raised from seeds gathered from wild plants growing in the mountains of western China suggests that the plants may be freer from disease than many of the long cultivated forms. The second plant is an Orange and still unnamed. It is said by Wilson to be the best of the tight-skinned Oranges of China. It is a low level plant in the Yangtse Valley but should prove hardier than the ordinary cultivated Orange. I could send you fifty or one hundred plants of each of these if you can use them to advantage among your friends in Louisiana. I think these trees should be introduced. Let me hear about this as soon as you conveniently can.

101

November 22, 1915.

I have yours of the 20th and you may be sure we shall send you a set of Palmer's plants as soon as they arrive. He is now working on them in St. Louis and I expect something from him very soon.

It would certainly be remarkable if you have found *M[agnolia] cordata* in Louisiana. As you know perhaps, it has recently been rediscovered in Georgia. If you have specimens of the leaves I should like to see them as they throw some light on the identity of the plant.

We are arranging to send you two hundred and fifty of the Ichang Orange and two hundred and fifty of the Ichang Lemon for distribution among your friends in Louisiana. We can send more if you want them. The Arboretum will take the liberty of paying the express charges on the case to New Orleans as you ought not to be put to any expense in this matter.

102

December 7, 1915.

The *Citrus* fruit started from here last night in two cases by express and I have no doubt will reach you in good condition. They have been inspected and I do not think there can be anything the matter with them. Now if you can use more of these plants to advantage in Louisiana we can send them to you. I am anxious, of course, to get them as widely distributed as possible. I advise you to try a few of *Citrus ichangensis* at your place in Alabama. This ought to prove, judging from the locality where the trees grow naturally, the hardiest of all the *Citrus* species with edible fruit. If you want more you better let me know soon before winter really sets in.

Crataegus 964 from Sardis, 1915, is evidently *C. tomentosa*, although I have n't seen the flowers, and the same as your 14 Sardis, 1914. These are the only Alabama specimens of this widely distributed tree we have

and I have no other record of its extending into Alabama, so this is another tree the distribution of which you have greatly extended.

103

December 14, 1915.

I have just been looking over the Louisiana specimens of *Malus*.

Your Pineville specimen, our #1 west of Opelousas, the Crowley specimens and your specimens collected at Natchitoches April 15, 1911 and April 15, 1912, and Palmer's Natchitoches 7252 we are placing with *M*[*alus*] *ioensis* var. *Palmeri*. This leaves now only our Malus #2 west of Opelousas, a tree thirty feet high with red-brown bark. This is certainly something different. It may be an extreme form of *M. angustifolia* but I hardly think so. I had supposed you collected flowers but I do not find them, although you visited the tree the second time to collect fruit. The flowers if possible should be collected in the spring.

I have just written Harbison that we have n't got to the bottom yet of the Selma-Sardis species of *Malus* and I hope he will visit that locality again next spring.

104

December 16, 1915.

In writing you yesterday I made a mistake, of course when I said we had referred your Pineville *Malus* to *ioensis* var. *Palmeri*. It is, of course, the type of *ioensis creniserrata*.

105

December 18, 1915.

I am very glad indeed to hear that the *Citrus* plants reached you in good condition. We have plenty more of them and I shall be glad to send you another supply if you can use them to advantage. I do not suppose the Orange is going to prove of much value but the so-called Ichang Lemon I believe will turn out to be a plant of much economic value.

Yes, I remember about the *Crataegus* from Louisiana and will get to it before long I hope.

Ashe is a man who is apt to make a good deal of trouble and I suggest that you be cautious about sending him material. He has a way of not keeping specimens on which he makes species and then forgetting them himself. How about the *Magnolia cordata*?

106

December 22, 1915.

We have no specimen of *Quercus cinerea* collected in Louisiana by you, and only one specimen in the state recently collected at Natchitoches by Palmer. Does not this tree occur in eastern Louisiana and have n't you seen it in other places in western Louisiana?

107

December 31, 1915.

I have been looking over your Sardis specimens of *Quercus*.

#800 with "bark like the White Oak" is what Harbison feels sure is Small's *Q. austrina*, but the old fruit which you picked up from the ground with this specimen is probably *Q. texana*. The following are also *austrina*: 804, 958, 956, 930, 950, 934, 902, 932. This seems to be a good species and to be widely distributed. You ought to find it in eastern Louisiana.

944, 960, 972, *Q. Durandii*.

898 and 912, *Q. coccinea*, new variety.

942?, 900, *Q. rubra*.

914, Sardis, looks like a hybrid and should be followed up. I cannot guess at its parentage.

932 might be *Q. Durandii* or *austrina*. It is sometimes very hard to distinguish these from leaves alone.

802 I take to be *Q. texana*.

2524, near St. Francisville, Louisiana (no fruit) must be a form of *Q. falcata*.

This is enough for today.

108

January 8, 1916.

I have your note about *Quercus austrina*. I confess that without acorns I cannot tell *austrina* from *Durandii* with any degree of satisfaction. Apparently what we are calling *austrina* according to Harbison is sometimes a large tree, and the tree which he considers *austrina* certainly always has scaly bark. Small, as you know, is often rather vague in his descriptions. Probably there is a good deal more to learn about these trees. P.S. — Do you know anything about an Oak collected by you in St. Tammany, July 1900, No. 6, and called by you *Quercus tomentosa* or *Q. velutina?* It is not that species and the leaves are good Red Oak leaves, and the fruit is good *coccinea* fruit. It is probably a form of the Red Oak with cups shaped like the northern form (*Q. ambigua* or *borealis*). I should think this was a tree worth further investigation.

109

January 13, 1916.

I enclose a leaf of an Oak specimen gathered by you in New Orleans in October 1911. Was this tree planted? This is the same tree as the one which is growing at Natchez, Mississippi, and of which Harbison has found a single planted individual by an abandoned house near Selma. With the leaf is an acorn from one of the Natchez trees. At Natchez most of the leaves are still on the trees and perfectly green, so that if this tree has been planted in the streets of New Orleans you ought to be able to recognize it at this time. The same species grows on the Texas coast and it would be surprising, I think, if it does not turn up in West Feliciana.

It is certainly an undescribed Oak and one of the largest Oaks of North America. It is well worth hunting for, therefore, in Louisiana. I have only just found out about the persistent leaves which add a good deal to the interest of the tree.

I enclose also a copy of Buckley's description of his *Quercus Shumardii* which has always been overlooked or disregarded. Judging from his description, it is a tree with foliage a good deal like that of *Q. texana* but with cups as shallow as those of the Red Oak but covered with very thick scales. I enclose a couple of cups of what I suppose is this tree from Fulton on the Red River in Arkansas. Our *Quercus texana* collected last April at Lake Charles may be this tree, and Palmer appears to have found it at Natchitoches and Grand Ecore. Your Sardis 1906 and 1915 may be the same thing.

I doubt if 1900 and 942 of Sardis are *Quercus rubra*, but your Sardis specimen of August 1913 is certainly this last. The trees which I think are *Shumardii* have more deeply lobed leaves than *Q. rubra* and large and very conspicuous axillary tufts of hairs on the lower surface. Typical *texana* has deep cups with thin scales.

Unless some character besides the shape of the cup and the thickness of their scales can be found to separate *Q. Shumardii* from *Q. texana* I should think that the former was a variety of the latter, but this group needs a great deal more observation in the field. It is true that *Q. rubra* evidently grows in Feliciana, but I do not feel at all sure that it is in western Louisiana. It is important to collect more material of the Red Oak group about Sardis if you are there again, and particularly in Louisiana.

I am writing to Palmer to pay especial attention to it in Arkansas, Oklahoma, western Louisiana and Texas this year. I should think that the Oaks of West Feliciana especially needed attention. I feel almost sure that you will find the new Natchez species there. If this tree from New Orleans, of which I now return a leaf, was planted where did the trees come from? Probably not very far from the city. This, however, is not a swamp tree so possibly it did not come from the immediate neighborhood of the city.

Do you remember the peculiar Post Oak with white scaly bark growing in low wet ground west of Opelousas? The leaves are not pubescent on the lower surface like the peculiar Post Oak of the Natchitoches region, and apparently they lose the stellate pubescence from the upper surface very early in the season. We have never had the mature leaves of this Opelousas tree and fruit has never been collected; this is a Louisiana tree which certainly needs further investigation. Either it is a new species or a very distinct form of the Post Oak.

I thought at one time the Hickories were bad but I must acknowledge the Oaks are more troublesome, and certainly they are now less well known than the Hickories.

Quercus Shumardii. — [This name is followed by the direct quotation of Buckley's original description, which ends the letter.]

110

January 15, 1916.

Referring to the Opelousas *Malus*, No. 1 is from the clump which the negro carried you to see but which I did not see. This we call *ioensis* var. *Palmeri*. No. 2 is the solitary large tree with red-brown bark which we saw later but further east. This we first collected October 10, 1913. We have from you a specimen called No. 2 collected in April 1914, but there is not a trace of a flower on this specimen.

On the label of your No. 1 collected April 1914 you say "large tree." This I take for granted is the negro tree. On the label of No. 2 you say "large tree, not in clumps."

Don't you think it would be a good plan for you to revisit Opelousas this spring and get good flowering material of this No. 2 which probably has very little to do with variety *creniserrata*? This will give you an opportunity, too, to take a look at the peculiar Post Oak which does not grow very far from it and quite near the *Quercus ludoviciana*.

111

January 21, 1916.

I have just finished looking through Palmer's autumn collection of Oaks. His Natchitoches 8761 and 8762 represent my idea of *Quercus Shumardii*. The buds show that this tree is in no way connected with *Q. rubra*, but I expect it will be found to be a variety of *Q. texana*. This last is well represented by Palmer's 8835 from Chopin. His Windsor 8935 has, as you see, shallower cups and appears to be approaching *Shumardii*. His *Q. breviloba*, Natchitoches 8718, is *Q. Durandii* and this is the first specimen of this species which I have ever seen from Louisiana, although it used to be said to grow on the banks of the Red River at Shreveport. If it does grow there I have never seen specimens. This fine tree can now, I think, safely be added to the Louisiana flora.

The next time you go to Covington would it be too much trouble to cut for me a piece of a stem of the *Illicium* about six inches long and as large a piece as can be conveniently found? It is wanted here for one of my associates who is studying the anatomy of woods.

Have you ever been to Port Hudson and do you know what grows in that region? I should like to go there again myself for it is fifty-three years since I saw it. Have you ever been up the railroad northward from Laurel Hill? This goes on to Woodville, Mississippi, which must be an entirely unknown Oak [region] botanically.

112

January 22, 1916.

I have your two notes of January 18th and the two cups. The more shallow one with the much thickened scales is my idea of typical *Q[uercus] Shumardii*. The specimen with the thinner scales seems to me to be a shallow-cupped *texana*, that is it has the thin scales of that species. What

I think is that these things run together and that *Shumardii* must be considered a variety of *texana*. It has been planted a good deal in the streets of New Orleans and I have collected there acorns with deep and with shallow cups. You say that your two trees can be distinguished in the field but how? It would be very useful if we could so distinguish *Shumardii*, otherwise than by the thickened scales of the cup and keep it as a distinct species.

How large are the specimens of the Natchez Oak [11] in New Orleans? If these planted trees came from Covington it ought not be too very difficult to find these species growing wild there. Have you noticed whether the New Orleans trees are still retaining their leaves?

I enclose an extract from Palmer's last letter. Do you know these regions?

"In Winn Parish, some distance n. e. of Natchitoches, there is a peculiar region with limestone bluffs and saline springs, so different from any of the surrounding country that it should produce something of botanical interest, also in going north from Natch. I passed through a region of nearly pure sand some miles south of Bienville where *Quercus brevifolia* seemed to be very common. I only saw it from the train but wished I could have gotten into it. If you are in that part during the summer and it is convenient I should very much like to spend a day or two with you about Natchitoches and Chopin, where there are a great many good things to be seen. The accommodations at Natchitoches are very good and I spent sufficient time about there to know something of the surrounding country." Have you noticed whether the New Orleans trees are still retaining their leaves?

113

January 26, 1916.

Many thanks for the package of specimens. The two Oaks are just my idea of *Quercus texana*. *Malus* #2 from Opelousas certainly should be followed up. It seems intermediate between *angustifolia* and *ioensis* and nearer the former. The bark as I remember it is different from that of any of our American species. This may be something new.

We have a specimen of *Magnolia* collected by Mohr near Mobile with the cordate leaves of your specimen. The Mobile specimen has always been considered an *acuminata*, and I think it is probably a variety of that species. The leaves are not at all like what we call *cordata*. This of course is a tree to follow up.

114

February 8, 1916.

I have been trying to group all the *Tilia* material in this herbarium with the following results as far as your specimens are concerned:

Alabama. #1, bluffs of the Alabama River. A species with glabrous branchlets, thin cordate leaves stellate-pubescent below throughout the season. I collected specimens last April near Sardis and you collected it in

[11] *Q. comptonae* Sarg.

1914; no other date on the label and no number. This species has not been collected and these are urgently needed.

#2, *Tilia heterophylla* Ventenat, not of Sargent's Manual, = *T. Michauxii* of Nuttall but not of Sargent's Manual. To this species I refer your numbers 780, 782, 790, 792, and many specimens collected by Harbison.

#3, a glabrous species with very coarsely serrate leaves, your 6, 784, 786, and 788, "near Selma, 1914," and Selma, June 12, 1914. This might pass for a green-leaved form of *T. floridana* if the leaves were not so coarsely serrate. If these specimens had been found in the north they would certainly be referred to *T. americana*. I feel very doubtful about this tree of which we have good material. Your specimen from West Feliciana, June 1907, called *T. americana*?, is evidently the same thing. This makes three species for Selma.

Louisiana. #1, branchlets glabrous, leaves stellate-pubescent below through the season. Lake Charles, your 2530 from the Mills Place. I had supposed that the Avery Island plant with leaves pale pubescent below belonged here but I find on the upper surface of the leaves the remains of stellate-pubescent hairs. These are very unusual on the upper surface of *Tilia* leaves and the Avery Island plant may be something entirely distinct. I much want to see the very young leaves of your Lake Charles tree and fruiting specimens of the Avery Island tree. I have placed with the Lake Charles tree Palmer's following numbers from Natchitoches Parish. —

8747, 7946, 7397, 7474, 7554, 8013, 8021, 7420, and the specimen collected by you at Natchitoches April 15, 1911. Palmer's 7675 from Welsh is probably the same as it has glabrous branchlets. All these specimens are very incomplete and we ought to have more and better Lake Charles material of this number.

#2, a perfectly glabrous species with leaves green or more or less glaucous on the lower surface. This is our #2 of last spring from Lake Charles, and Palmer's 7644, 7673, 8523, 7574, 7342, 7694, 8510, your 2534, your Lake Charles specimen of March 26 and May 12, 1911, and your Shreveport specimen of June 1908. What I believe is the same species but with leaves more or less glaucous on the lower surface are Palmer's 7923, 8699 and 7569. These specimens with glaucous leaves I do not know how to distinguish from *T[ilia] floridana* of Small, and I do not see how to distinguish the glaucous and the green-leaved specimens specifically. We have only very incomplete material of this #2 from Lake Charles.

#3, a species with glabrous branchlets, young leaves stellate-pubescent but soon becoming glabrous, and usually conspicuous tufts of axillary hairs. Your 2528 from West Feliciana seems to be this species which is our #3 of Lake Charles and Palmer's 7523, 7956, 7554, 7479, 7474, 7952, 7397, your Natchitoches specimen April 27, 1911, your Lake Charles 2530 and 2536, Palmer's 8511, 7695, your Lake Charles October 1914, your Winnfield April 6, 1913, our Opelousas April 3, 1913, your Laurel Hill March 1910. This seems a widely distributed species in Oklahoma, eastern

Texas and Arkansas, and gets into Mississippi. Our Louisiana material is still very incomplete, especially that from Lake Charles.

#4, a tree with pubescent branchlets and leaves rusty tomentose below. Your 2532 (3 L. C.) from Lake Charles, and Palmer's 7674, 8500, and perhaps 8494 but of this the branchlets are glabrous. I suppose that the "Tilia pubescens" of Avery Island belong to this species. There are no fruiting specimens of any of the above numbers and they are urgently needed.

I should say then that there are certainly four species in Louisiana. If, as I suspect, the Avery Island specimen with young leaves stellate-pubescent above is a species, there would be five, and if the glabrous tree with very coarsely serrate leaves from West Feliciana can be separated from *T. floridana*, then there are six species.

The important species to work up are the two species from Avery Island, the fruit of #4 from Lake Charles and the young leaves of your Lake Charles #3. It is important to compare young leaves of all the species because the conditions of their early pubescence may be very helpful in distinguishing the species.

I had hoped that we had reached the end of the southern *Tilias* but evidently we are still very far from that I fear. It is astonishing how the peculiarities of the southern trees have been overlooked or neglected.

There is confusion I am sure about that Mills Place Lake Charles number.

115

February 10, 1916.

I am sending you under another cover the cup of a very small Oak fruit and a cup and nut of a larger one. These seem to have been both gathered by me at Laurel Hill when we were there together. We have young leaves which belong to the small cup and these leaves seem to be *Q. texana*. The shape of the cup is all right for that species but of course is exceptionally small. The large acorn and cup would pass here at the north perfectly for a Red Oak. Unfortunately there are no leaf specimens which belong with this acorn. It appears to be in an exceptionally good condition if it was picked up from the ground in March, which was the time we were at Laurel Hill.

If the Red Oak gets at all into Louisiana I suppose it would be in West Feliciana, and I am sending you this material in the hope that it may help you in studying this group. Of course it is desirable to determine, if we can do so, the true range of the Red Oak. Undoubtedly what has been called Red Oak in the south is often *Shumardi*.

Ames and I are starting about the 10th of March for a short trip in Arizona, but my idea is to stop a day in New Orleans to talk matters over with you and then on the way back to stop again, if you think it desirable to do so, and return home by Natchez. All this, however, can be decided when I see you in New Orleans on the way west.

116

February 19, 1916.

I have yours of February 15th. Please take another look at your *Tilias* 784 and 788 from Selma. The flowering specimens look rather different but I cannot find much difference in the fruiting specimens. How do you distinguish these two trees? The truth is we have got to live with trees in order properly to understand them. Herbarium material is really of very little good except as a record. These two numbers look very much like the *Tilia* from west Louisiana.

In order to meet engagements further west Ames and I would have to be in New Orleans on the morning of March 16th when I hope the crowd will have left. We had best write, I think, for our accommodations at the hotel. I should like to devote a part of the day to going over with you your specimens of *Tilia* and *Quercus*. Our plan now is to be back in Louisiana in April, but about this we can confer on March 16th.

117

February 23, 1916.

I have just been through all the Hickory material of the 1915 collections. The most interesting thing for us now in Louisiana is your Natchitoches #6 of 1913 and 1914, for which I long ago wrote out a description, but I had so little material that I did not do anything more about it. I believe that Palmer's Natchitoches 7258 (see this), which he called *C[arya] alba*, may be this same tree, and I believe also that the two small trees which we found in dry woods just before we got to the quarry at Winnfield April 6, 1915, may be the same. We thought at the time they were *C. alba*, but of course they have nothing to do with that species. These trees ought to be followed up, and if you cannot get there in the autumn perhaps Palmer can.

I suppose that those miserable Monroe Hickories which have bothered us so much, judging by the buds, all belong to *C. arkansana*, but they did not have good *arkansana* bark. It would pay to get spring material which would show the young leaves.

In spite of the very differently shaped fruits which used to puzzle us so much I now believe that the following Natchitoches numbers must be referred to *C. arkansana*: Cocks 10, xi, 12, 16, 20, Palmer 1 and 3, also Chopin 1 of Palmer, Lake Charles 1 of Cocks, and Cocks and Sargent, Lake Charles (yard of J. Mills).

Your Grand Ecore 3 of 1913 may also be *C. arkansana* with small globose nuts. It is important to see your leaves of this number. Can you find the tree or tell Palmer how to do it? Grand Ecore, Palmer 7524, Creston 7016 Palmer seem to be *C. arkansana*.

1 and 18 of Natchitoches which I had placed with *C. megocarpa* [sic] are evidently *C. arkansana*. I feel very doubtful about 2 and 5 of Natchitoches and I should like to see young leaves of these numbers. 5 may be *C. arkansana* but I am doubtful about 2. It is possible that the flowering and fruiting specimens are of different species.

I hope you can get together all the specimens about which I have been writing you lately so that we can discuss them on the 16th of March when we shall not have any too much time I fear.

118

April 24, 1916

I got home Saturday night after a successful two days in Natchez and one day in the neighborhood of Jackson where unfortunately Harbison did not turn up.

Miss Compton has now located in Natchez twenty-nine or thirty individuals of the new Oak. All the old trees are in the neighborhood of buildings but some of these must be so old that I am inclined to believe that they must be original trees left standing when the forest was cleared. We saw, however, two wild trees, one growing in a field far from any houses and probably thirty or forty years old, and one much smaller in the woods. The relationship of the trees certainly would be Live Oak and I believe should be looked for on high ground and not in swamps. The largest specimen near Natchez is fully one hundred feet high and another tree has a trunk about five feet in diameter. Several of them are much larger than the tree we showed you on the Duncan place.[12] It is as evergreen as *Quercus virginiana* and is certainly one of the finest Oaks in the United States. I hope you will be able to locate the wild trees in Louisiana.

The Maple tree from which we collected on our way to Natchez and which you thought was *Acer leucoderme* is evidently the same form of Sugar Maple that grows in West Feliciana and is evidently a distinct form.

I shall hope soon to hear about your visit to Sardis. I enjoyed our days together immensely and certainly West Feliciana can produce as fine trees as are to be seen in any part of the United States.

119

May 3, 1916.

I think it would pay you when you are in West Feliciana Parish in the autumn to look into the Beech question a little and collect good fruiting specimens from a number of trees. I collected only two specimens this spring and these represent the northern species, *F[agus] grandiflora*, and the southern variety, var. *caroliniana*. The curious thing about it is that the under surface of the leaves is very pubescent. The pubescent *grandiflora* has been described as forma *pubescens* and apparently has only been collected before in New England. What is more interesting perhaps is that the leaves of the specimen of the variety *caroliniana* are also pubescent on the lower surface. This has been described as forma *mollis*. Apparently it has only been collected once before, at Tallahassee by Nash in 1895, and in Louisiana (New Orleans) by Drummond in 1832.

[12] "Duncan Park" of Dr. STEPHEN DUNCAN of Natchez.

This collection seems to give you two new varieties for Louisiana. It would not be a bad idea to collect *Fagus* in any part of the state you may visit.

I hope you are finding the new Oak.

P.S. — The right name of the shrub we found so common and naturalized by the roadsides near Laurel Hill is *Pyracantha crenulata* Roemer.

120

May 10, 1916.

Many thanks for the package of specimens which arrived yesterday.

Tilias.

820. This is the species with leaves stellate-pubescent on the lower surface while young, becoming glabrous, and small but conspicuous axillary tufts. This seems to be the commonest Linden of Louisiana and southern Arkansas.

822. The glabrous, early-flowering species I suppose. There is a trace of axillary clusters on this particular specimen, the flower-buds appear although the leaves are not much grown.

834 = 822.

836, *T. heterophylla.*

832 = 822 and 834, I believe.

4014 is what we have been calling *T. floridana.*

4016, the species with pale pubescence on the lower surface of the leaves. This, according to the original description, should be *T. leptophylla.*

4012 = 4016.

4010 = 4014.

2530 = 4016.

Alabama 842 = *Malus angustifolia.*

Alabama 844, *Amelanchier.* Mature leaves and fruit desired if not already sent.

Quercus 838, Sardis. This certainly outdoes *Shumardii* as we have seen it in Louisiana.

I notice that you are quite cautious about giving names to your Oaks and I do not know how to tell the young leaves of *austrina* from those of *Durandii.* I hope you can do so.

Notice your 840 which has stellate pubescence on the upper side of the leaves. Is this a Post Oak? What is 830 from Pine Bank Creek with its long-stalked fruit? Can this be the Natchez tree or is it what you call *Q. austrina?*

I hope to hear soon from you again.

121

May 23, 1916.

Much obliged for your letter of March [sic] 18th. I am glad to hear that you found *Carya pallida* in Louisiana. I notice what you say about the lateness of *C. alba.*

I have noticed in different places in the South individual trees of what I supposed was *C. alba* which were very much later in coming out than is usually the case with this tree. I have not been able, however, to follow up any of these trees to find out if they had other peculiarities. I suppose you can recognize in the autumn these late trees and it would be well, of course, to collect fruit and leaf specimens. These may show some characters which would make it possible to distinguish the late trees as a variety.

I do not think I ever wrote you about *Quercus velutina*. My variety *missouriensis* was based principally on the stellate pubescence on the upper side of the leaves. I saw at Jackson this spring a small tree with these stellate leaves but the inner bark was not yellow like the inner bark of the common form of *Quercus velutina*. It is possible that this stellate pubescence and the gray inner bark may have some relationship and make it possible to distinguish another form of this tree. Harbison has noticed the same thing in Mississippi and western Florida, and I think it would be well for you to bear this in mind and keep a lookout for Black Oaks.

There is certainly an undescribed species of *Malus* at Sardis, your numbers i., ii. and iii. The leaves on the flowering branches of this tree look exactly like those of *M. angustifolia* but the mature leaves, especially on the shoots, resemble those of some of the forms of *M. ioensis*. Possibly the *angustifolia* which you sent me the other day may belong to this tree. I have n't got time to look at the specimens this morning however. I will write you later on this subject. Harbison says that the young leaves of *Q. austrina* are perfectly glabrous.

122

June 1, 1916.

Have you ever collected *Halesia carolina* in Louisiana? If so, we have no specimen in our herbarium. My Manual speaks of it as growing through Louisiana to eastern Texas and Arkansas. West of the Mississippi we have one specimen collected in northern Arkansas, nothing from Louisiana or Texas. It appears to be common at Selma. It is possible that the description of the range has got to be modified.

123

June 8, 1916.

I am very glad indeed to get at last the Avery Island *Tilias*. They do not look at all as I thought they were going to and seem to be the same as three common species at Lake Charles. So much the better, for the fewer species we can get on with the better.

What do you know about the distribution of *Asimina triloba?* We have Louisiana specimens only from Wakefield and Natchitoches. Does it grow in eastern Louisiana, and how does it happen that it does not grow at Sardis? We have no Alabama specimen whatever in the herbarium.

124

June 19, 1916.

I have yours of the 14th from Sardis where I hope you are not suffering too much from the heat. I am just going to begin to arrange this spring's collecting of *Tilia* and will write you again on that subject.

I have given up trying to understand *Q. Durandii* and *Q. austrina*. Harbison, however, thinks he knows these trees as far off as he can see them and I am enclosing your note to him. The leaves of *Q. Durandii* vary more on the same tree than those of any other Oak I have seen. On the lower branches they are very often deeply lobed and higher on the tree entire, and sometimes green and glabrous below or pale and pubescent, although I believe the pubescent leaves are more common than the glabrous ones.

I will ask Harbison to write you just where he found the Natchez Oak near Sardis and I hope you will be able to locate the tree and find others. Palmer has failed to find it where Mohr collected in Texas twenty-six years ago, so we know it only as a tree growing near human habitations.

125

June 30, 1916.

Perhaps you will be interested in reading the enclosed from Harbison. Please let me have it back sometime. Notice what he says about the difference in *Tilia* at the top and bottom of the trees, and also about *Quercus*. You and he between you ought to be able to get to the bottom of this *Quercus austrina* business.

126

July 5, 1916.

In spite of all our efforts the Louisiana *Tilia* material here is still very incomplete and unsatisfactory, as you will see by the following. My present idea is that Louisiana specimens can be grouped as follows:

A. The perfectly glabrous species without axillary tufts of hairs.

Lake Charles.

Cocks, May 12, 1911, no number, good flowers.

May 21, 1915, 2534, good flowers.

Palmer, 7644 in bud, 8523 sterile.

Sargent, river bank, April 12, 1915. #1 yard of C. J. Mills, sterile. River bank, April 13, 1915, #1, sterile.

St. Francisville.

Sargent, April 12, 1916.

Laurel Hill.

Cocks, March 1910, sterile.

Natchitoches.

Palmer, 7569 in bud, 7523, good flowers. These Palmer specimens have leaves glaucous below but are probably a form of species represented by Group A.

Please notice that we have n't a single Louisiana fruiting specimen of this group. The tree is common in Mississippi and reaches Texas and Alabama, and your Sardis 786, of which we have three fruits I think is the same.

B. This is the species with large leaves very oblique at the base, early in the season very thin, bluish green, lustrous and slightly pubescent below, especially on the midribs and veins, usually soon becoming glabrous, axillary tufts small, often wanting. My #2 of Lake Charles, April 13, 1915, is my idea of this species. We also collected it March 26, 1911. It is your 4014, Mills Place, April 3, 1916.

Lake Charles.

Palmer, 7694 in bud, 8510, sterile (bracts but no fruit), 7695 in bud, 8511, sterile.

Avery Island.

Cocks 4050 and 4052.

Natchitoches.

Palmer 7574, sterile, 8699, sterile, 7956 and 7963 with flowers.

Welsh.

Palmer 7673, sterile.

Chopin.

Palmer 7342, sterile, 7970, poor flowers.

Grand Ecore.

Palmer 9449, sterile.

East Opelousas.

Cocks 401, sterile.

Shreveport.

Cocks, 10, June 1908. D. Coty, no date.

West Feliciana.

Cocks, 2540, flowers and fruit.

I should have liked to have made my #2 of St. Charles the type of this species for the young leaves look so distinct, but if you can get fruit of Avery Island 4052 that might be taken as the type. This tree grows also in Texas and Arkansas but we have no very good material from those states.

Sardis.

Cocks 822 and 834, April 20 and 22, 1916, and 788, flowers and fruit complete.

I once thought 788 belonged to Group C but the leaves are very oblique and bluish below. The tufts of hairs are prominent on this specimen, but I do not know how to distinguish these numbers from the Avery Island tree. Are 822 and 834 from the 788 trees? It would be well to get fruiting specimens of these numbers. Please write me, too, the sort of place in which this tree grows, the height of the tree approximately, diameter of trunk, nature of bark, branching, and any other information you can supply as we may have to take the Sardis plant as the type of the species in case we cannot get more Louisiana material.

C. Leaves more or less cordate, dull green when young on the lower surface, more pubescent than those in Group B, becoming glabrous, axillary tufts large and conspicuous.

Lake Charles.

Cocks 2536, flowers just opening May 21, 1915.

West Lake Charles.

Cocks, October 1914, no number, sterile.

Near Alexandria.

Cocks, June 1905, in flower?

Shreveport.

Palmer 9479 in bud.

Opelousas.

In rich woods, Sargent, March 29, 1900, and April 3, 1915, both sterile.

Natchitoches.

Palmer 7523 and 9416, both sterile.

St. Francisville. Cocks 2523 in bud.

Sardis. Cocks 820 and 832, April 20, 1916, sterile. We should have more specimens of these numbers.

D. Leaves mostly very oblique at the base, rusty pubescent below during the season.

Lake Charles.

Cocks 3, 2530, flowers, fruit and young leaves, and 2532. The branchlets of 2532 are pubescent and those of 2530 are perfectly glabrous. How about getting fruit of 2532?

Avery Island.

Cocks 4054 in flower May 24, 1914, is evidently the same but the branches are more pubescent.

October 18, 1900, a sterile shoot.

Welsh.

Palmer 7674, 8500, 8495, all sterile.

E. Leaves smaller than those of the last group, mostly cordate, densely pale stellate-pubescent below during the season but the pubescence is not closely attached and can be easily rubbed off.

Lake Charles.

Sargent 3, April 13, 1915. Several sheets, all sterile. One specimen taken near the schoolhouse in West St. Charles [West Lake Charles intended] has pubescent branchlets; those of the other specimens are glabrous.

Natchitoches.

Palmer 7420 in bud, 7946 in flower, 8747 sterile, 7474 in bud, 7952 in flower, 7479 in bud, 9416 sterile, 8013 sterile, 8021 sterile, 7397 sterile.

Cocks, April 27, 1911, in bud, no number; April 15, 1911, sterile, no number.

Chopin.

Palmer 7554 in bud.

Welsh.

Palmer 7675, sterile.

East Opelousas.

Cocks, 4312 and 4016, sterile.

Winnfield.

Sargent, April 6, 1913, sterile. We have no fruit of this tree from Louisiana, and you do not appear to have collected any specimen in the state.

The specimen of 2530 taken April 3, 1916, at the Mills Place seems to belong to E rather than to D. Are there not two species on that wretched Mills Place?

This seems to make five species in the state, although it may be difficult to separate B and C with the material we have.

At Sardis there is a Linden with oblong finely serrate thin leaves pale pubescent below during the season and obliquely cordate at the base. We have a sterile branch collected by you in 1914, no date and no number. I collected what I think is the same on the bluff near Sardis April 19, 1915, sterile shoots only. I don't think this is your 788, and I don't find that you have sent flowers or fruits. Possibly your Sardis 22 and 23 belong here. These two sheets look abnormal. The leaves are very long-pointed, very coarsely serrate and oblique at the base. These trees should be followed up and more material obtained.

Your Selma 784 and 6, and also several other unnumbered sheets collected in 1914, bother me a good deal for I cannot find any way to separate them from *T[ilia] americana*. *T. americana*, however, is a distinctly northern tree as we now understand it and does not appear to extend south of Pennsylvania and northern Missouri. Please look at these trees and see if the leaves are lustrous below and if there is any pubescence on them except the axillary tufts. I am afraid that your specimen from Wakefield, Louisiana, June 1907, is the same.

Have you ever heard anything from our Laurel Hill friends and are they collecting any material for us? Don't you think it would be a good plan to ask them to get fruiting specimens of all the different Lindens in that neighborhood?

Memorandum.

Tilia material needed before these trees can be properly described.

A. Fruiting specimens from Louisiana and Sardis 786.

B. Fruiting specimens from Avery Island 4050 and 4052, and from Lake Charles where it appears to be a very common species.

C. Fruiting specimens of Cocks's 2536, Lake Charles, and fruiting specimens at Sardis 820 and 832.

D. Fruiting specimens of Lake Charles 2532, Avery Island 4054.

E. Lake Charles fruiting specimens.

Sardis. Fruiting specimens of Cocks's 22 and 23, also of the species collected by Sargent on the bluffs April 1915.

Additional material of 784 and 6.

127

July 12, 1916.

Of the *Quercus* of your last sending two specimens (no numbers) called *Durandii* and *austrina* are both *Durandii*.

958 is my idea of *austrina*. 960 I suppose is a good *Durandii*. These species are easily distinguished by the fruit.

820 I should call *Durandii*. 824, probably *austrina*. 826, *Durandii*. 840, *Durandii*. 830 I do not know but it may be *austrina*.

958, 970, 956, 950 and 934 appear to be some form of the Post Oak.

The small tree by the stream at the foot of this hill where we were stuck, and called both *austrina* and *Durandii*, I now think is the Post Oak with scaly bark.

4022, West Opelousas, is the Post Oak like that at Natchitoches.

I enclose another communication from Harbison. Between you I think you ought to be able to clear up this Oak business this year.

I take it that your Sardis *Tilia* 952 and 954 is the one I collected on the bluff near Sardis about which I wrote you the other day. This tree apparently grows at River Junction, Florida. We have no flowers or fruit.

You called your Sardis 950 *T. floridana*. Have you ever seen this before?

How does your Hickory which was so late in putting out its leaves look now?

If you stay late enough in Alabama it would be a good idea to get some acorns of your peculiar hybrid Oak 938 to plant, as these hybrid Oaks are interesting and it is possible that it might be hardy here.

Too bad that you and Harbison did not connect!

128

August 7, 1916.

It is a long time since I have heard from you although Harbison wrote me the other day that he had a letter from you telling him of the floods in your region. I hope your crops are not ruined. Farming in the South seems to be a very precarious business.

The young leaves of *Quercus austrina* as collected by Harbison are perfectly glabrous and I think all the specimens which you have sent under that name are either *Durandii*, which seems to be a common tree with you, or forms of the Post Oak. I trust you will be able to get a good supply of *Quercus* material so that we can settle this year some of these doubtful points.

I have pretty much come to a conclusion about Lindens, or most of them, and will write you on the subject in the course of a few days. I wish you would take a look at *Magnolia glauca* and perhaps make some specimens. Harbison has recently found a shrubby form with perfectly glabrous peduncles, while in the form which grows to a large tree the peduncles are densely covered with snow white silky hairs. At the north the plants are shrubby and the peduncles are glabrous. Most of our

southern specimens have silky peduncles, especially those from Natchitoches collected by Palmer. I do not think we have any specimens from Sardis and shall be glad to have them.

If it is any hotter in Alabama than it is here today I am sorry for it.

129

August 9, 1916.

I have this morning yours of August 3rd. You must have had a horrible time and I fear that your crops are ruined.

I think we are slowly getting a little light on the *Tilia* situation, but it is a tedious and difficult job because material is often so fragmentary. There are certainly a number of new species. I notice that your 2530 from Lake Charles has perfectly glabrous branches and that 2532 has pubescent branches. We have flowers and fruit of 2530 but only flowers of 2532. I hope therefore that the new Louisiana collections may include fruit of this number. These numbers must represent the same species in spite of the branches. The lower surface of the leaves is covered with matted stellate pubescence which is easily rubbed off and not like the close persistent tomentum which you find on several of the Sardis species. This Lake Charles tree, which is also common in the coast region of Texas, does not seem to extend east of the Mississippi River.

I hope soon to hear that things are in better shape in your part of the world.

130

August 26, 1916.

Thanks for yours of the 21st which I find after a short visit in Illinois and St. Louis.

No, that *Crataegus* won't do for *C. aprica*. It is no doubt an undescribed species.

I went to St. Louis to see Palmer who was arranging his spring collection. He has a good deal in the autumn to do in Texas and I have told him that it was not absolutely necessary for him to get back into western Louisiana this autumn. He thought, however, he might do it. He reports very large trees of *Quercus Durandii* in Natchitoches, so that is another Louisiana tree. Apparently they are doing nothing in St. Louis in the way of distributing his plants and claim they are not going to distribute anything until they can make a critical study of them. I am sorry about this and if you can designate exactly what you need I will make another attempt to get them for you.

If you get this note drop me a line as to where you are to be in Virginia as I am going there myself in September and it is possible we might meet.

131

September 28, 1916.

I have yours of the 19th. I wrote you on August 9th & 26th & told you of

the safe arrival of the specimens & suggested that we might meet in Virginia whence I have just come. Have you specimens of the late *Carya alba* about which you have written me or if not can you get them?

I will write a real letter when my secretary gets home.

132

November 16, 1916.

It is a long time since I have heard from you and I hope that silence does not mean that you are entirely swamped by those Alabama Oaks and Hickories. The Oak business seems to be endless, for now Harbison feels quite sure that he has found a new species near Vicksburg. I have n't, however, seen his material.

I am writing especially today to tell you that we are sending you by mail two plants of a Chinese vine, *Sargentodoxa cuneata*. We think here it is going to be a good thing as in China, at least, it grows vigorously and has fragrant yellow flowers. Will you "place" these two plants where they will be likely to be taken care of? I am rather anxious about these because I am afraid this plant will not prove hardy in the north.

Hoping to hear from you soon, I am,

133

November 18, 1916.

According to Harper, "Mr. Mattoon of the U.S. Forest Service claims to have found *Pinus caribaea* in eastern Louisiana this year. Dr. Mohr did not seem to have any information about its occurring in Louisiana when he mapped its range, and I did not see any of it west of the Pearl River when I visited New Orleans in 1905."

Have you any views one way or another about this tree in Louisiana?

134

December 30, 1916.

I very much fear there are three species of *Tilia* on Avery Island.

First, *Tilia floridana,* Cocks 4052, May 29, 1916, and 4042, July 28, 1916.

Second, *Tilia ambigua*, n. sp., Cocks 4050, May 29, 1916; Miss McIlhenny, June 8, 1915, "the smooth barked Linden." This is a common western Louisiana species and our No. 2 of Lake Charles. It is one of the trees which has been placed under lettophila [sic], which name I now want to abandon as the identification is not possible.

Third, *Tilia Cocksii*, Cocks (4054) May 29, 1916. (4040) July 28, 1916. "The rough barked Linden," Miss McIlhenny, June 8, 1915. This looks superficially like some of the Lindens from the coast of South Carolina and Georgia which have been called *Tilia pubescens* but is distinct from them in its glabrous branches and buds. I have seen nothing like it except these Avery Island specimens and I wish we could find it in other localities. I hope, however, that we are going to Avery Island in

the spring and then perhaps we shall be able to see more of these trees.

This is only the first paragraph of the Linden dose I am going to send you very shortly.

With best wishes for the New Year, I am,

135

January 2, 1917.

I have determined some of your Alabama *Tilias* as follows:

T. Harbisoni, n. sp., near Selma, 1914, Cock's 780, 790 and 792. This is a common west Florida species and I think a good one.

T. floridana var. *oblongifolia*, n. var. 788 type, 820, 832, 834, 952, 954, 958, also near Selma 1914. This is a common Louisiana tree about which I shall write you later.

T. nuda, n. sp. 95, June 6 and July 28, 1916; 954 (= 956 of 1915), June 28, 1916. Where is 956? I do not find it here. This is a perfectly glabrous species which is common in Mississippi, Louisiana, Arkansas and eastern Texas. Selma appears to be its most eastern station. The trees at Natchez, Mississippi, I have taken as the type.

Hutchins' Run, Cocks's 970, July 26, 1916, with partly grown fruit. This differs from all other species of the United States' *Tilias* which I have seen in the long hairs on the fruit, and if this is a constant character I suppose this is a distinct species. If you can locate the tree so that Harbison can find it in early spring; flowers and mature fruit will have to be collected either by him or by you.

964, 966 and 968, Hutchins' Creek, Cocks, June 27, 1916. This looks like what we have been calling *T. heterophylla* but flowers are needed. Can you locate these trees for Harbison? 962 Hutchins' Creek may be the same but the branchlets are much more slender and the buds smaller.

782, limestone cliffs of the Alabama River at Cocks's place, June 15, 1915, has slender light yellow branches and seems different from any of the others.

836, young leaves, April 21, 1916. I do not connect this with any of your other specimens. What is it?

Your Selma 1110, May 5, 1913, which seems the same as Selma June 30, 1915, I cannot place. Complete material is needed.

I am still in doubt about your Sardis species which we have thought might be *T. americana*, represented by your #6 of July 14 and #784 of June 2, 1915, by specimens collected in June 1914 and by #960, July 25, 1916. Specimens from West Feliciana and from Alexandria seem to be the same. The axillary tufts of hairs which are so conspicuous in *Tilia americana* are smaller and often wanting from your specimens. Can you tell me if your #822, April 20, 1916, is from one of these trees? If not, Harbison ought to look them up and get young leaves. I suppose you can tell him where to find them. The fruit appears to be usually depressed-globose. I do not know, however, how to really distinguish these dried specimens from *T. americana*, but central Alabama is a long way from the home of *T. americana*.

When we see how difficult it is to get complete material of these southern Lindens it is not at all surprising that they have been misunderstood and neglected for so many years. I am afraid there is still a good deal of field work to be done on them. If you can give Harbison the information how to find the doubtful numbers he can go there this spring and obtain the young leaves, always supposing that you were unable to do so. Of course you could probably find the trees much more easily than he could. In case you can not go will you get into communication with him?

136

January 4, 1917.

Will you send me your full name so that it can appear with the description of *Tilia Cocksii*, also can you give me the Christian name or names of Miss McIlhenny who sent me specimens from Avery Island?

As you know, there are on the Louisiana coast region a number of islands similar to Avery Island. Have they ever been explored botanically, and don't you think this ought to be done in connection with this *Tilia* business. It seems fair to presume that the vegetation on these islands would be very similar. We certainly ought to try to find *Tilia Cocksii* in more than one place.

137

January 6, 1917.

I have referred the Louisiana species of *Tilia* as follows:

Tilia ambigua, n. sp. Our Lake Charles #3. Avery Island, Cocks' 4050; Chopin, Palmer 7554; Creston, Palmer 7420; Welsh, Palmer 7675, 8494; near Winnfield, Cocks and Sargent, April 6, 1913. East Opelousas, Cocks 4012 and 1016; on Little Bayou Teche, Cocks 4018.

Please notice that we have neither flowers nor fruits of this species from Lake Charles. We have a very poor flowering specimen from Avery Island but no other flowers from the state, and fruit only from Little Bayou Teche.

T. floridana, Small, West Lake Charles, Cocks, October 1914 (no number); Lake Charles, Cocks 2536, 2530, 4014; our #2 of Lake Charles: Palmer, Lake Charles, 7695, 8511.

Notice that from Lake Charles we have partly expanded flowers on your #2536 but no other flowers and no fruit at all.

Avery Island, Cocks, 4052 and 4042. Grand Ecore, Palmer, 9449; Chopin, Palmer 7970, 7342; Natchitoches, Palmer, 7574; Shreveport, Palmer, 9479, 10608; Welsh, Palmer, 7673; East Opelousas, Cocks, 4010, 4020; West Feliciana, Cocks, 2540; St. Francisville, Cocks, 2528; near Laurel Hill, Cocks and Sargent, April 12, 1916; West Plantation, Bayou Sara, Cocks and Sargent, April 14, 1916.

There is good material from Avery Island, 4020, East Opelousas, has good fruit. 2540, West Feliciana, has a few open flowers. All the other specimens are very incomplete.

Tilia floridana, var. *oblongifolia*, n. var. Laurel Hill, Cocks, March 1910; Natchitoches, Palmer, 9437, 8699, 9416, 7956; Grand Ecore, Palmer, 7523; Chestnut, Palmer, 9462.

Natchitoches 7956 has good flowers but there are no other flowers and no fruit of any of the Louisiana specimens.

Tilia rhoophila, n. sp. Lake Charles, Cocks, 2530 (I am doubtful about this), 2532; Welsh, Palmer, 8500, 7674.

There are good flowers of 2532 but no fruit, and all the Welsh material consists of young shoots. 2530, Lake Charles, has glabrous branches and buds and may be *T. Cocksii*. This species, if it is one, needs investigation in Louisiana.

Tilia nuda, West Feliciana, Cocks, 4024; Lake Charles, Cocks, May 12, 1911, 2530, 2534, Palmer 7644, 8523, our #1 of Lake Charles.

T. nuda, var. *glaucescens*, n. var. Natchitoches, Palmer, 7569, 7923.

The type of this new variety is Cocks Sardis 786. We have no flowers or fruit of the variety from Louisiana, and only two fruits from Sardis and none from Texas.

With *T. Cocksii* this makes five Louisiana species without the Sardis species with coarsely serrate leaves like those of *T. americana* which, judging by the two fragmentary specimens, also grows in Louisiana. On the whole our Louisiana material is not at all satisfactory. When we remember how much time and trouble we have taken to get together the small amount we have it will perhaps be understood why these southern species have been so much neglected and overlooked. Certainly there is no other genus which is more difficult to collect material in a saitsfactory condition.

A common Lake Charles tree our #2 with leaves at the end of May very thin, blue-green and nearly glabrous below is interesting. It belongs with the *floridana* set but perhaps should be distinguished as a variety. Palmer 7694 and 8510 from Lake Charles may be the same but I am not sure, and probably Natchitoches 8697 may be the same form. We have no flowers and no fruit of this tree from Lake Charles and we ought to try and get them. I take it for granted that you know the form I am talking about as you collected it at Lake Charles March 26, 1911 (no number).

I wish you would think over the situation and decide if possible if you will be able to obtain some of the material we need this year. The important things to get are flowers and fruits of this Lake Charles *Tilia floridana*, and material and information of *T. rhoophila* from Walsh. Palmer has a good deal of *Tilia* work to do in western Texas this year and it is desirable that it be arranged so that we will not be obliged to go into Louisiana at all this season. I take it for granted that you will be able to get off for a week or ten days about April 1st for a trip into western Louisiana, and also for your proposed expedition with me into the country adjacent to the Illinois Central Railroad. Apparently there are no Lindens in East Louisiana except in West Feliciana; we at least

do not seem to have any specimens from that part of the state. How about this?

As the nature of the pubescence is the best character by which to distinguish the various species it is essential to collect in the spring the half-grown leaves. It is necessary therefore to visit trees three times, in the spring for young leaves and in the summer and early autumn for flowers and fruit. The color of the branchlets and the character of the winter-buds have been almost entirely overlooked, and it will be laborious and expensive to get these in addition to the spring and summer material. All these southern trees ought to be grown in New Orleans where they could be easily seen and satisfactorily studied. You need an arboretum there very badly.

138

January 12, 1917.

I enclose a provisional conspectus of the United States species of *Tilia* based on the material already in hand. It will require considerable changing probably when we are successful in getting all the material we need this year. I am sure we have n't got to the bottom yet of the distribution of these trees. For example, we know nothing of Lindens in Louisiana east of the Mississippi River with the exception of those in West Feliciana; certainly there must be others. And we know nothing of Lindens in any of the coast region of Mississippi or Alabama, Selma and Sardis being the most southern station in Alabama from which I have seen specimens. There must be Lindens on or near the gulf coast of Mississippi. If you do not mind doing so I wish you would ask Tracey [sic] if he has not collected Lindens along the southern coast. Lindens are so common on the Carolina and Georgia coast, and so common in places like Lake Charles, that it would be surprising if they did not occur in the coast region east of the Mississippi River.

Many thanks for your letter just received this morning. I will make the corrections you suggest and write you again in a few days.

Conspectus of the [*Tilia*] Species of the United States.

Surface of the leaves glabrous at maturity.

Surface of the leaves glabrous or almost glabrous as they unfold.

Leaves furnished with conspicuous tufts of axillary hairs, their lower surface light green and lustrous; pedicels glabrous or nearly glabrous. 1. *T. glabra.*

Leaves without tufts of axillary hairs, their lower surface not lustrous; pedicels densely hoary tomentose. 2. *T. nuda.*

Leaves finely serrate, yellow-green, oblique or cuneate at the base; tufts of axillary hairs small, rusty brown. 3. *T. littoralis.*

Leaves minutely dentate, yellow-green, without tufts of axillary hairs. 4. *T. brevipedunculata.*

Leaves crenately serrate, glaucescent on the lower surface, the tufts of axillary hairs usually wanting or minute. 5. *T. crenoserrata.*

Surface of the leaves stellate-pubescent below early in the season, becoming

glabrous or nearly glabrous before summer, glaucescent or green, often without tufts of axillary hairs. 6. *T. floridana.*

Surface of the leaves pubescent or tomentose below through the season.

Lower surface of the leaves stellate-pubescent.

Pubescence short, gray, firmly attached; leaves coarsely serrate; tufts of axillary hairs not conspicuous, sometimes wanting; pedicels sparsely stellate-pubescent, becoming glabrous. 7. *T. neglecta.*

Pubescence white, slightly attached.

Branchlets and winter-buds glabrous or very rarely pubescent in No. 8.

Leaves dark green, finely dentate, oblong-ovate, mostly oblique or cordate at the base; tufts of axillary hairs minute. 8. *T. ambigua.*

Leaves blue-green, coarsely serrate, orbicular to suborbicular, symmetrically cordate at the base; tufts of axillary hairs conspicuous. 9. *T. phanera.*

Branchlets and winter-buds pubescent.

Leaves finely serrate, oblong-ovate, obliquely truncate or cordate at the base, up to 12 cm. in length. 10. *T. texana.*

Leaves very coarsely serrate, ovate to orbicular, mostly cordate at the base, not more than 8 cm. in length. 11. *T. grosseserrata.*

Surface of the leaves tomentose below with close firmly attached tomentum; branchlets glabrous.

Leaves broadly ovate, short-pointed, mostly cordate at the base, their tomentum silvery white or grayish. 12. *T. heterophylla.*

Leaves oblong-ovate, long-pointed, mostly oblique and truncate at the base.

Leaves silvery white on the lower surface; flowers at least 10 mm. in length, on sparingly pubescent pedicels; branchlets stout; winter-buds compressed, 10–12 mm. in length. 13. *T. monticola.*

Leaves silvery white or brownish on the lower surface; flowers 5 or 6 cm. long, on densely pubescent pedicels; branchlets slender; winter-buds terete, 5 or 6 mm. in length. 14. *T. Harbisonii.*

Surface of the leaves tomentose below early in the season, becoming floccose pubescent, the pubescence more or less firmly attached.

Young leaves stellate-pubescent on the upper surface.

Leaves often broader than long, dark green above, silvery white on the lower surface; branchlets glabrous or stellate-pubescent during the first season; winter-buds glabrous. 15. *T. amphiloba.*

Leaves longer than broad, yellow-green above, white or brown on the lower surface; branchlets tomentose during their first season, becoming pubescent; winter-buds covered with rusty brown pubescence. 16. *T. georgiana.*

Young leaves not stellate-pubescent on the upper surface.

Winter-buds glabrous.

Branchlets sparingly pubescent early in the season, becoming glabrous or nearly glabrous; lower surface of the leaves rusty pubescent.

Leaves coarsely serrate, their pubescence thin, slightly attached, sometimes entirely deciduous late in the season; flowers 9 or 10 mm. in length. 17. *T. caroliniana.*

Leaves less coarsely serrate, their pubescence firmly attached, persistent through the season; flowers 4 or 5 mm. in length. 18. *T. Cocksii.*

Branchlets pale pubescent during at least two seasons; lower surface of the leaves white pubescent. 19. *T. nivea.*

Winter-buds pubescent.

Pubescence on the lower surface of the leaves and branchlets gray or rusty, that of the leaves only slightly attached. 20. *T. rhoophila.*

Pubescence on the lower surface of the leaves silvery white, the pubescence slightly attached.

Branchlets covered with close pubescence, becoming glabrous in their second year; flowers 7 or 8 mm. in length, the corymbs densely stellate-pubescent. 21. *T. cheiophila.*

Branchlets covered with long rigid hairs mostly deciduous at the end of the first season; flowers 5 or 6 mm. in length, the corymbs covered with straight hairs. 22. *T. trichoclada.*

139

February 9, 1917.

Hickories. 6 of Natchitoches. We used to think this was a new species but I am convinced that the flowering specimen collected in April 1914 is *C[arya] alba*, and that the fruiting specimen collected in October 1913 and the fruit is *C. arkansana.*

#1 of Natchitoches, October 1913, seems to be *C. ovata.*

The *Carya* in dry woods before reaching the quarry at Winnfield, a tree with slender glabrous branches, young leaves nearly glabrous above and hoary-tomentose below. This is not *arkansana, alba, ovata, ovalis, megacarpa, callicoma* or *leucodermis.* What is it? It has always bothered me. Can't you settle this problem this year?

Carya #5, Natchitoches, Cocks, October 1913. This has stout glabrous branches, buds the size of those of *C. ovata*, and stellate pubescent rachis and midribs of the leaves. The fruit is pear-shaped with a thick husk splitting tardily and looking like some of the forms of *C. arkansana.* Unless there is some mixup here I do not know it, but if the fruit and leaves do not go together I do not know the leaves unless they may be some extreme form of *ovata.* 2 and 17 of Natchitoches seem the same. I once thought that 17 was a *callicoma* but these Natchitoches numbers have small obtuse buds covered with yellow scales and are entirely different from the buds of *callicoma.* The young leaves of 2, however, show no trace of the yellow scales, so that it cannot be an *arkansana.* Another species? I hate to think so. Some of the other Natchitoches and Grand Ecore numbers which I have placed with *arkansana* may be the same thing and it is possible, of course, that this may represent another species for western Louisiana seems capable of anything in the tree line.

Have you found out anything more about that Alabama *alba* which leaves out so late? I think I saw the same thing once near Natchez. It may be some variety which we have not got hold of yet. I wish you would go over your Hickory material and see if you can throw any light on any of the numbers I have written to you about today. I had hoped that we had finished the Louisiana Hickories but there seems to be still a little to do at Natchitoches and especially at Winnfield.

140

February 14, 1917.

Here are some of the results of Rehder's visit to New York:

Vitis rufotomentosa. The Louisiana specimen referred by Small to this species of his was collected by Hale near Alexandria and was called by him *V. aestivalis.* The best character by which *V. rufotomentosa* can be distinguished from *V. aestivalis* is in the pubescent branchlets and pedicels. According to this Palmer's 7974 from Chopin, Louisiana, would be *V. rufotomentosa.* Harbison has found it at River Junction, Florida, so there is no reason why it might not grow in Louisiana. I shall ask Harbison to look for it in Alabama and Mississippi. If you want therefore to keep *V. rufotomentosa* distinct from *V. aestivalis* you can include it in your Flora on the strength of Palmer's specimen. I do not believe myself that it is very much of a species. The *Vitis* with pubescent stems, however, ought to be looked for in eastern Louisiana.

Of *Vitis caribaea*, which Small also credits to Louisiana, there is no specimen in the New York herbarium, and only four from Florida. On one of these some one has written "Florida to Louisiana." I think you can safely drop this species as a Louisiana plant for there is nothing to show that it grows there.

Bumelia lucida Small. This is based on a specimen collected by Carpenter in 1838. His label reads, "No. 19, Prinos new? Small tree 10–20 feet high; limbs rigid, some short ones resembling thorns. Grows in thick woods, Feliciana, Louisiana. Flowers in June and 1st of July; berries purplish black. Dr. Carpenter, 1838." Before Small got hold of it some one labeled it "B. lycioides Pursh." I should think it probably a form of *B. lycioides.* It certainly does not look, however, like your specimen of that species collected at Wakefield in 1907. You may be able to find Carpenter's plant yet. In the shape of the leaves it looks like a sterile specimen collected by Letterman near Opelousas in August 1882 and preserved in the St. Louis herbarium.

Bumelia cassinifolia Small is based on a specimen collected by Letterman in August 1883 near Opelousas. We have a photograph of the type specimen and a single leaf. The leaves are obovate, rounded at the apex, thin, glabrous and not conspicuously reticulate. This specimen is certainly different from that collected by Letterman referred to above and preserved at St. Louis. We have what seems to be the same as Small's *B. cassinifolia* from Paradise Key in the Everglades of Florida, from Mosquito Inlet and St. Marks, Florida, and from near Bainbridge, Georgia. This last is a shrub growing in moist soil. These Florida specimens have slender glabrous pedicels and rounded calyx-lobes.

I think you ought to be able to find this plant near Opelousas. If not, I should think you could include it in your Flora on the strength of Letterman's specimen in New York.

Of *B. lycioides* we have from Louisiana only your Wakefield specimen and we should have more of it and know more about the distribution of this tree in the state. I think it must be common in western Louisiana.

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February 15, 1917.

Your unnamed *Vitis* No. 9, Richmond Parish, June 1909, is *V. palmata*. This seems common in western Louisiana as Palmer got it at Monroe and Natchitoches. I suppose you have Palmer's specimen No. 8006, *V. rupestris* from Natchitoches, June 1915.

I am sorry to hear that there is another den of *Tilias* in western Louisiana for I fear it is filled with trouble. I suppose you will pay a visit there and I shall be glad to hear of the results.

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February 23, 1917.

Do we know enough about *C[arya] leiodermis* and have we ever had fruit from more than one tree? Except by the color of the young leaves and by the much thicker husk of the fruit can *leiodermis* be distinguished from *callicoma?* Are you sure that the young leaves of *leiodermis* are not red or sometimes red? We ought to have a great deal more fruit of these two Hickories. Even if the distinctive characters hold good might they not better be considered varieties of one species? Why cannot our unknown Winnfield Hickory be *leiodermis*, of which we have no very young leaves?

143

April 9, 1917.

Biloxi is a wonderful place for Live Oaks and I wish you had been there with us. There are two very distinct forms, one with young leaves nearly grown and pale and slightly pubescent on the lower surface. These trees are like the one which we collected at Springfield. The second form is a tree still covered with last year's leaves which are dark green and very lustrous on the upper surface, coated below with thick white tomentum, strongly revolute and very conspicuously reticulate-venulose. These trees were not in bloom and have lost none of their old leaves. This second form was what I supposed was the typical *Quercus virginiana*. We saw nothing like it in Louisiana. It would be strange, however, if it did not extend into the southeastern part of the state and I should expect it at Slidell. Have you ever been there?

I understand that your Live Oaks at New Orleans are green and glabrous on the lower surface and I wish you would dry me some specimens showing their present condition. I very foolishly omitted to do this and in this herbarium there is only one specimen of *Q. virginiana* collected by me in western Louisiana many years ago. I do not find in our Texas material specimens with leaves as thick and tomentose as those on the trees of Biloxi but what appear to be a good many intermediate forms. It is evident that *Q. virginiana* has been shamefully neglected.

That curious White Oak which we found in the road from Springfield

seems to agree with Michaux's *Q.*[*uercus*] *alba repanda* which is a good name for it. It would be interesting to get good leaves and fruit from this tree which seems to be exceedingly rare.

We are having today what appears to be the severest snow storm of the winter and I wish I was back in some comfortable place like Opelousas, although I daresay Ames does not share this opinion. I will write again in a few days as soon as I get things a little in order. I think we had a wonderfully good trip this year. I can't have too many Live Oak specimens from different trees.

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April 11, 1917.

T. W. Adams, Greendate, Canterbury, is the name and address of the New Zealand man who cultivates Conifers and Oaks so successfully and apparently has a wonderful collection of trees. I wonder if your people know him.

I have a note that *Pinus glabra* grows on the Amite River. Did you supply this information and, if so, can you give me the exact locality where you found the tree? This must be the extreme western limit of its distribution.

I understand that the only place where you have found *Kalmia latifolia* in Louisiana is in Washington Parish. If so, this is probably its western limit and the talk in my Manual of its occurring in western Louisiana and southern Arkansas must be incorrect; at any rate we have no specimens here from that region.

In the March issue of Torreya which arrived this morning there is an article by Wilbur R. Mattoon of the Forest Service on the extension of the range in Louisiana of *Pinus caribaea*. According to him there are pure stands of this tree covering mile after mile along the New Orleans Great Northern Railroad, and that logging and turpentine operations are carried on there by several large companies. He observed it between Slidell and Covington. From Covington to Hammond he found it confined to ponds and along streams, and spread over large areas of flat lands further east. About Hammond he noticed it quite common in young stands and scattered groups. This was the most western point this man visited. He says that "its occurrence south of Hammond along the Illinois Central right-of-way suggests the high probability that it occurs to the north and to the west doubtless as far as the natural barriers formed by the extensive outlying swamp and overflow lands of the Mississippi River." He says, — "The region, it would seem, affords an excellent opportunity for some one to look for a further extension of the western limit of this interesting and very valuable commercial Yellow Pine." How about this, and if it does grow at Hammond how did we happen to miss it? This seems to be a thing to look into. I will try and get some of Mattoon's specimens, but as Hammond is of easy access from Louisiana you will no doubt have an opportunity to verify his observations.

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April 13, 1917.

Was it *Ilex cassine myrtifolia* or *Ilex lucida* which you said you had not been able to find in Louisiana? We have a specimen of *Ilex lucida* from you, your Pearl River No. 81, no date, with *Ilex Dahoon* on the label. In our herbarium I do not find any *Ilex cassine myrtifolia* west of Alabama. I saw a plant of *Ilex cassine* (Dahoon) growing in the lake at Avery Island but failed to take a specimen. We have no Louisiana specimen of this tree. It does not seem to be anywhere very common, and I should like to know about its distribution in Louisiana and to get Louisiana specimens if possible.

Ilex lucida is common at Biloxi.

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April 16, 1917.

Is the *Tilia* by the river (the tree I did not see) from which you collected this sprig the same as your 2532 (3 Lake Charles) of May 21, 1916? Your 2530, June 1, 1915, from the Mills Place seems the same. If these are all one species *T. rhoophila* as a Louisiana tree will have to disappear, and we should have to consider that the young branchlets of *T. ambigua* are sometimes pubescent and that the pubescence of the leaves of this tree sometimes becomes brown before the end of the summer.

Tilia Cocksii. I understand that your 4040 and 4054 are from the tree at Avery Island which you showed me. If this is true it would seem that there is no way of really learning anything about these southern Linden trees except by visiting them every day from March 15th to September 1st. My last visit shows that there is no use trying to do anything with them worth while with only herbarium specimens gathered twice a year to depend on.

The *Carya* by the roadside near Loranger with slender branchlets and stellate pubescent young leaves and evidently small buds may be some form of *C. alba* but I think you should try and get the fruit. These trees seem to be the only strange-looking Hickories we saw this year.

As I understand it *C. callicarpa* becomes *C. leiodermis*, *C. leiodermis* becomes a variety, and *C. ovalis subglobosa* becomes *C. leiodermis*, which is something gained.

I enclose a bit of my specimen of the Winnfield Hickory which does not look like what you showed me. Is it possible that my specimen is *C. leiodermis*. What seems to be the same tree grows at Natchez. I think it desirable to investigate Winnfield in the autumn. There is that comparatively smooth *Bumelia* from Avery Island which needs further investigation. Can you manage that?

Don't you want to lend me the fruiting specimens of the new Oak with rhombic leaves which you showed me the other day? I am afraid that we shan't be able to get fruit of this tree this autumn owing to spring frosts.

[*To be continued*]

ANATOMY OF THE PALM RHAPIS EXCELSA
I. MATURE VEGETATIVE AXIS [1]

MARTIN H. ZIMMERMANN AND P. B. TOMLINSON

DIAGRAMS PURPORTING TO REPRESENT the course of vascular bundles in palm stems are reproduced frequently in textbooks. These seem to be based less on direct observation than on figures copied from earlier publications. Reasons for this are obvious. Palms are essentially tropical organisms and are not commonly available to research workers. Moreover, palm stems are too large and too complicated to lend themselves easily to standard botanical microtechniques. Workers of the nineteenth century, despite their limited technical facilities, made much more progress than their modern counterparts.

Von Mohl's classic and unexcelled work (1824–1849) is the prime source of our present understanding of the anatomy of the palm stem, as has been shown in surveys of the history of the subject (Branner, 1884; Monoyer, 1925; Tomlinson, 1961, 1964). The development of this understanding up to the time of Von Mohl and subsequently has been traced by Monoyer and is best illustrated by the series of diagrams in FIG. 1, reproduced largely from his paper, together with Monoyer's diagrams of the stem of "*Cocos botryophora*" (*Arecastrum romanzoffianum* (Cham.) Becc., see Moore, 1963), based on his own observations and reproduced here as FIG. 2. In addition to surveying the literature both Branner and Monoyer made significant contributions to the subject. Branner attempted to explain the distinctive curvature of individual leaf traces in palm stems as a mechanical consequence of their appearance in the meristematic region of the palm stem (cf. also Schoute, 1903; Arber, 1925, p. 35 [2]). According to Arber, Von Mohl appreciated the mechanics of the curvature in 1858.

Monoyer was concerned much more than previous workers with anastomoses between individual bundles and the way in which the vascular network constitutes a pathway for long-distance transport. His own diagrams (FIG. 2) illustrate a regular system of bundle fusions. He

[1] This is a contribution to a major research program in which the structure of arborescent monocotyledons is being studied by one of us (P.B.T.). The program is supported by grants from the National Science Foundation (G.B. 506) and the American Philosophical Society (Penrose Fund 2959, Johnson Fund 488).

Subsequent articles will deal with leaf, root, and inflorescence insertion, seedling and rhizome anatomy, and general development.

Part of this paper, including a 12-minute analytical motion picture, was presented in the symposium "Long Distance Transport Phenomena" held during the X International Botanical Congress, Edinburgh, Scotland, August, 1964.

[2] It should be noted that Arber's diagram (*Fig. xvi*) is somewhat misleading.

shows a presumed bundle fusion (his *Pl. VIII, Fig. 4*) without commenting on anatomical details. Previously Lestiboudois (1840) and Karsten (1847) had recorded presumed fusions, but they were based on macroscopic dissection only. All other illustrations of fusions appear to have been inferred rather than observed (e.g., FIG. 1 E). Our own dye injection experiments suggest that interconnections between different vascular strands are numerous and physiologically very significant.

Monoyer's work was also important in suggesting differences between proximal and distal parts of a single palm stem (FIG. 2). This is a point overlooked by theorists who ascribe a simple "type" of construction to all palm stems.

We suspect that the essential features of the distribution of vascular bundles in palm stems has hitherto not been grasped except by Branner (1884). Early concepts of the growth of palm stems, now known to be false, were used by De Candolle (1813) in separating monocotyledons from dicotyledons as a major group. Monocotyledons do indeed differ in their basic construction from dicotyledons, but not in the way envisaged by De Candolle. The so-called "palm-type" of bundle distribution has long been regarded as one of the basic patterns in monocotyledonous construction (e.g., Falkenberg, 1876). It would evidently be useful to establish these concepts more factually.

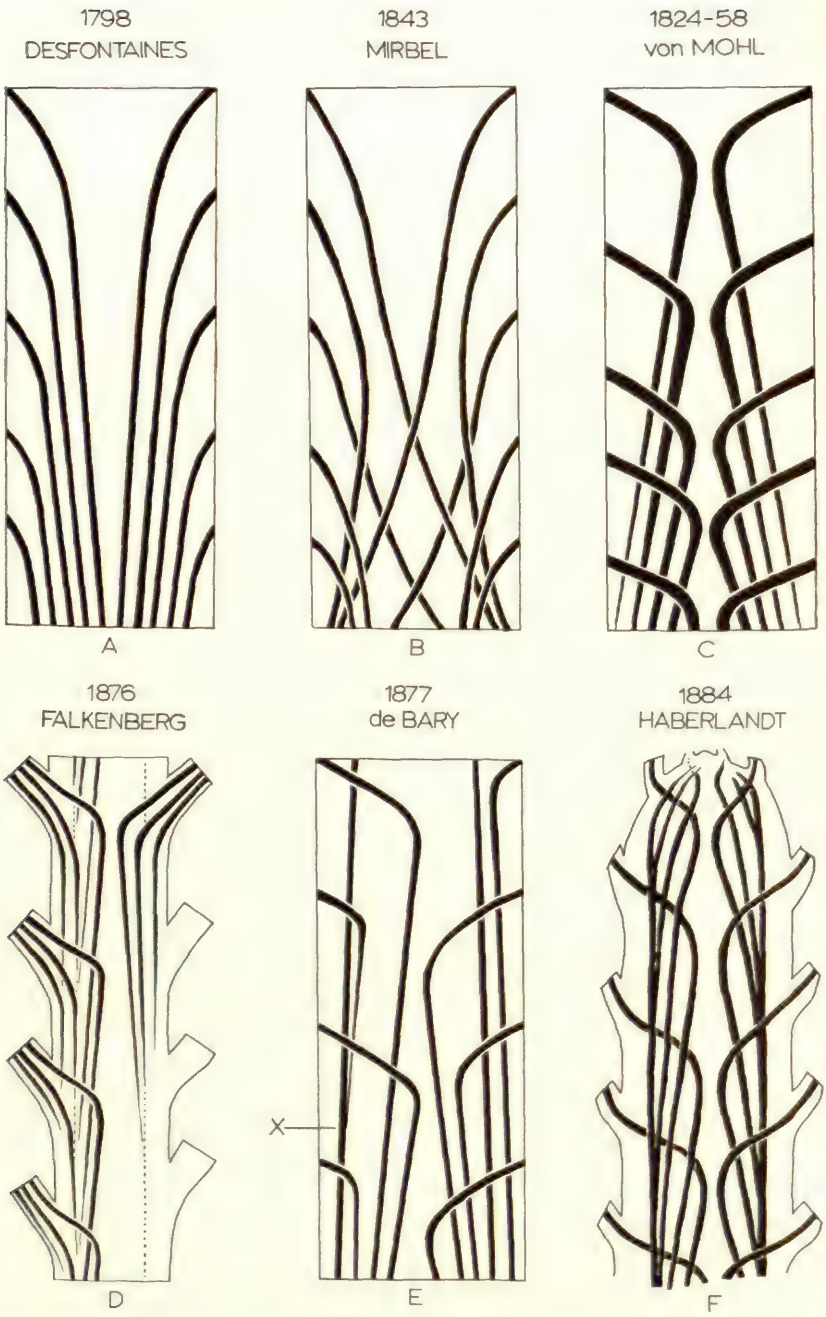
The present article is the result of the reappraisal of the problem at first hand. Von Mohl's general principles have been established on a quantitative basis for the first time and many new observations made. A much more accurate understanding of the structure of the palm stem and of the pathway for long-distance transport has now been reached.

Earlier observers give little indication of methods used in analyzing palm stems. Large scale dissection, particularly of partly decomposed trunks, has evidently been most used. This gives general information about the behavior of individual bundles, but the intimate relation between different bundles is lost, and anatomical details are overlooked. Macroscopic dissection cannot distinguish easily between temporary juxtaposition of two bundles, which is frequent where they are congested, and true vascular anastomoses which are physiologically and developmentally important. Serial sections, less used by previous workers, have been mostly of small palms (e.g., Nägeli, 1858).

Our own study is largely based on serial sections, which means that the relative position and detailed anatomy of vascular bundles is preserved. Anatomical information is stored on ciné film so that large scale analyses which are needed become a relatively simple matter. In addition, this dynamic approach makes it easy to distinguish between important and unimportant vascular contacts.

GENERAL MORPHOLOGY OF RHAPIS

The problem was simplified by using the small palm *Rhapis excelsa* (Thunb.) Henry, a native of eastern Asia and a common ornamental in


1798
DESFONTAINES
1843
MIRBEL
1824-58
von MOHL
A
B
C
1876
FALKENBERG
1877
de BARY
1884
HABERLANDT
X
D
E
F

south Florida. Aërial stems 2–3 cm. in diameter and up to 5 m. high arise from horizontal rhizome segments up to 1 m. long. Younger, developing parts of each rhizome segment are protected by short, rigid scale leaves which are morphologically equivalent to the sheathing base of the foliage leaves of aërial stems. In older parts of rhizomes the scales decay, leaving annular scars at intervals of 1–3 cm. marking the nodes. Adventitious roots arise at wide but fairly regular intervals along the rhizome, commonly, but not exclusively at the nodes. After a period of horizontal growth the apical part of the rhizome enlarges appreciably and turns erect. There is a rapid change from rhizome scales to normal foliage leaves, the transitional leaves with increasingly developed blades illustrating that the scales are essentially foliage leaf sheaths without a blade. In the axils of several of the most distal rhizome scales new vegetative buds grow out as the rhizome apex turns upwards. Most of these lateral branches grow out horizontally as new rhizome segments; occasionally they grow erect as additional aërial stems. In the aërial shoot early growth is wholly vegetative, the foliage leaves subtending either no buds or, at the most, aborted inflorescences. The subsequent detailed account of the distribution of the vascular bundles deals entirely with this part of the stem uncomplicated by fully developed inflorescence insertions. In the distal parts, axillary inflorescences appear, internodes are shortened

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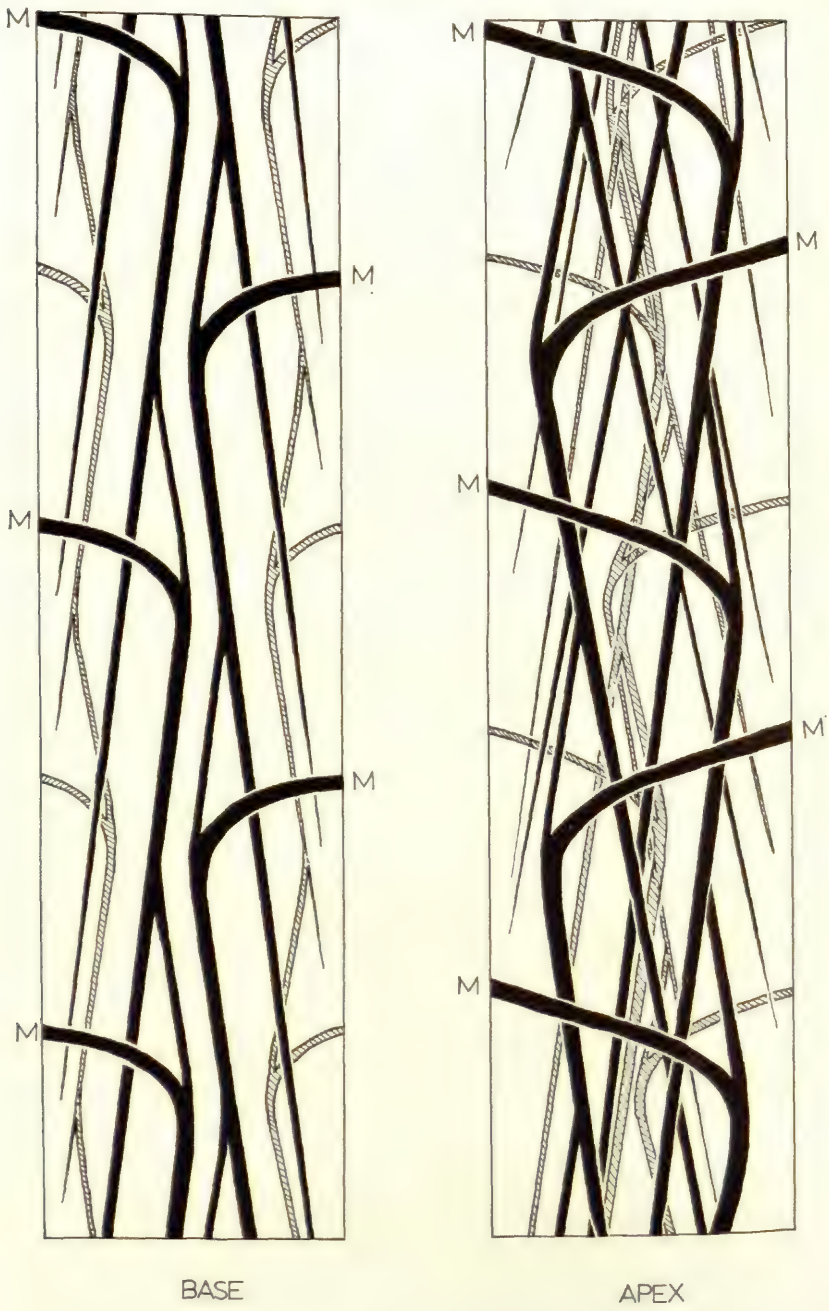
FIG. 1. Hypothetical bundle course of "palm type" according to various classical authors. A–E, redrawn from Monoyer, 1925; F, from Haberlandt, 1884. A. *Desfontaines* (1798). All bundles proceed to base of stem with a distal curve becoming parallel to the vertical axis of the stem below. Developmentally new bundles were supposed to arise in the stem center and crowd older bundles towards the periphery. B. *Mirbel* (1843). Two categories of bundle, the first extending from one side of stem to the opposite, the second restricted to one side of stem (see text p. 171). All bundles proceed to the base of the stem. C. *Von Mohl* (1824). All bundles proceeding to the base of the stem, all alike, initially curving abruptly towards the center and subsequently passing very gradually back to the periphery and ending blindly below. Later (1849) he suggested that the lower extremities of bundles might fuse. With either scheme the number of bundles at any one level remains relatively constant. D. *Falkenberg* (1876). Purporting to illustrate *Chamaedorea elatior* (and possibly derived from Nägeli, 1858, who studied this species), although, according to his text, Falkenberg studied only *Chamaedorea schiedeana*. Several categories of bundles, all ending blindly below, some extending much deeper into the stem than others. Dotted line represents boundary between cortex and central cylinder. E. *De Bary* (1877). A scheme derived directly from Von Mohl, without reference to Falkenberg's article. Considered according to a distichous phyllotaxis; dorsal bundles penetrating deeply, ventral bundles penetrating less deeply into the stem center. At "X" a tentative fusion is illustrated without comment. Diagrams in a number of modern textbooks appear to be based upon this diagram and incorporate a regular system of bundle fusions which have been inferred but never observed. F. *Haberlandt* (1884). From Falkenberg (1876), via Sachs (1882). A much-reproduced illustration purporting to represent the "palm type." It was actually drawn by Falkenberg to represent *Aspidistra elatior* (Liliaceae), a statement omitted from textbooks. It seems to bear little relation to actual palms. From this date on, the "palm type" of vascular construction has become entirely hypothetical.

MONOYER 1925



and the outline of the stem becomes more angular owing to the pressure of developing inflorescences. The anatomy of this part of the stem will be described in a subsequent article.

By choosing a palm of this stature the problem was reduced from the analysis of a stem like that of *Cocos*, which may be up to 0.5 m. in diameter with over 20,000 vascular bundles at any level, to one in which there were about 1,000. The relative ease with which the *Rhapis* stem could be sectioned freehand was a second reason for its selection. Clearly, principles based on the study of a diminutive palm must be verified by analysis of a much larger and more typical stem. The basic approach used in this work suggests that ultimately this will be possible. However, we already have much evidence from larger palms like *Chrysalidocarpus*, *Sabal*, *Washingtonia*, etc. which suggests that *Rhapis* is indeed a small-scale model for palm stems generally.

CINEMATOGRAPHIC ANALYSIS

Cinematographic analysis was accomplished by two different methods, namely, by photographing, frame by frame, (1) sequentially cut surfaces and (2) serial sections through the microscope. Kodachrome II, Type A film has been used throughout.

Surface photography. Photography of cut surfaces has been used only to a very limited extent with *Rhapis*. Pieces of stem were clamped in the specimen holder of a Reichert type OME sliding microtome, and thin shavings were taken with a frequently sharpened knife. The specimen holder was advanced for each cut along the optical axis of the camera, i.e., manually with the screw which raises the specimen holder. The specimen holder was modified in order to accept long pieces of stem. A scale marked in ink on the stem provided a means of measuring the rate of advance. The camera, a Bolex H 16 REX, was mounted on a sturdy stand above the specimen with the optical axis coinciding with that of the stem. A long focal-length lens (105 mm.) allowed the operator of the microtome ample working space. We developed this method ourselves but learned during the preparation of this manuscript that a similar, but automatic method for the analysis of short tissue pieces had been developed earlier by Postlethwait. In fact, the method seems to have been proposed as long ago as 1907 (Postlethwait, 1962).

Photography of serial sections. For the analysis of the course of

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FIG. 2. Course of vascular bundles in *Arecastrum romanzoffianum* (*Cocos botryophora*), according to Monoyer, 1925. Redrawn and slightly modified. *Base*. May be compared with De Bary's scheme, but with the addition of fusion bundles (*faisceaux de jonction*) which unite upper and lower bundles. M's (solid black) represent dorsal (major) bundles which penetrate most deeply into stem center. Ventral and minor bundles (cross hatched) have same course but penetrate less deeply into stem. Bundles are shown as ending blindly below. *Apex*. Essentially as in base but with bundles of both systems all extending more than halfway across stem. A likely explanation of this is given in the text (p. 171).

vascular bundles over long distances, sections 25–50μ thick were cut freehand on the same microtome at intervals of 0.5 mm. The automatic feed was set at 50μ and every 10th section kept. For easy processing each of the sections retained was tied with a constant orientation to a sequentially numbered slide by cotton thread. Orientation was facilitated by a shallow longitudinal groove scored along the stem and visible as a slight notch in each section. A small wad of glass wool between cotton thread and section prevented unstained thread marks across the section. Sections were bleached briefly in "Clorox," washed in water and 70% ethanol, stained overnight in a mixture of safranin (95 parts of a 1% solution in 70% ethanol) and Delafield's haematoxylin (5 parts), differentiated briefly in acidulated 50% ethanol, dehydrated, and mounted in neutral "Piccolyte." Sections at 0.5 mm. intervals proved adequate for general analyses as it was easy to trace a single bundle from section to section. For details of "rapid" changes which occurred at a node a complete series of sections approximately 30μ thick were prepared, passing through an entire internode about 2 cm. long which had been embedded in celloidin.

A piece of stem much longer than could be held complete in the microtome clamp was analyzed in shorter lengths. The upper part of each of these shorter segments was clamped in the normal way and as many sections as possible removed, then the lower part was held firm by freezing, in a 5% gum arabic solution, to the flat stage of a freezing attachment and the sectioning of the segment completed. We have now greatly simplified the procedure by the development of a modified clamp with which very long pieces of stem can be held.

The key problem is to match successive sections under the microscope so that a fixed point in the section successively occupies the same position on each frame of the film. So far this has been done by incorporating a camera lucida into the microscope-camera system in such a way that an outline drawing of every 2nd to 6th section is made and used to orient its successors precisely. The drawings are used as an additional permanent record, with the microscope-stage coordinates marked for about every 10th slide, so that, if necessary, it is possible to return to the slides at any later time and locate the photographed position. A Wild M20 microscope was used, with the parts assembled from below upwards as follows: microscope base with centerable rotating mechanical stage, objective turret, drawing tube, camera tube H, binocular. Viewing and focusing are done in the binocular; photographs are taken with a Bolex H 16 REX, which is mounted on a Wild camera stand.

It is often not necessary to have a permanent record of drawings and photographed slide positions. The extra labor of drawing can be eliminated with an optical "shuttle" system. A Wild discussion tube is mounted upside down on two microscopes; the images from these two microscopes are thus brought into a single camera and viewing system. Photographs are taken alternately through each microscope, the double image being used merely to superimpose successive sections precisely.

Analysis of films. For the analysis of films an L-W 224 A Photo-Optical Data Analyzer was used. This is essentially a 16 mm. movie projector modified by L-W Photo, Inc. (15451 Cabrito Road, Van Nuys, Calif.), so that a film can be projected without flicker at any speed from 1 to 24 frames per second, forward or backward. The film can be stopped instantly, and moved frame by frame. Less expensive projectors are available, and action editors are also usable for the purpose. However, the instrument we have used has proved ideal in every respect.

The vascular system of *Rhapis* described below has been resolved by an essentially dynamic process. This is reflected in the subsequent description which refers to the distribution of vascular bundles by a dynamic terminology. This is merely a convention. Changes in direction of mature bundles reflect changes in the angle of differentiation of bundles in meristematic regions. "The "movement" suggested by ciné analysis, particularly of one bundle in relation to another, is quite apparent and implies neither actual movement of bundles nor their growth.

GENERAL STEM ANATOMY OF RHAPIS

Stem (Fig. 7) divided into a narrow cortex less than 1 mm. wide and a broad central cylinder (15–30 mm. wide). Epidermis uniform, cells cubical or slightly tabular and somewhat elongated vertically; slightly anticlinally extended; outer wall thickened, wholly cutinized. Epidermal cells occasionally with lignified walls. Hypodermis of 2–4 layers of narrow cells scarcely differentiated from rest of cortical parenchyma but becoming thick-walled, lignified and conspicuously pitted in old stems and forming a continuous thin mechanical layer except for interruptions below occasional stomata. Cortical parenchyma up to 20 cells deep; cells isodiametric or slightly elongated vertically, becoming chlorenchymatous in exposed stems. Innermost layers of cortical parenchyma sometimes slightly lignified. Fibers common as thick-walled strands scattered throughout cortex. Peripheral strands narrow, purely fibrous, wider strands toward central cylinder often including a narrow phloem strand, or both xylem and phloem, and so transitional to cortical vascular bundles. Most leaf traces passing across cortex and entering central cylinder.

Central cylinder not delimited sharply from cortex by endodermis, parenchyma sheath or other specialized layer but by peripheral densely congested vascular bundles forming peripheral mechanical zone. Each peripheral bundle with a massive fibrous sheath; xylem sheathed only by narrow slightly thick-walled parenchyma cells. Bundles irregularly rhombohedral in transverse section, separated by narrow bands of short, slightly thick-walled pitted and subsequently lignified ground parenchyma cells, forming a reticulum between the congested bundles continuous externally with cortical parenchyma and gradually transitional internally to thin-walled somewhat looser, unlignified ground parenchyma of isodiametric or slightly elongated cells. Peripheral mechanical zone traversed by conspicuous leaf traces and associated bundles (vertical, bridge, and satellite bundles — see below). Vascular bundles towards center of stem gradually less congested and with reduced fibrous sheaths, becoming more circular in transverse outline. Isolated narrow fibrous strands very rare. Silica bodies in small isodiametric stegmata abundant next to fibers.

Tannin common in unmodified parenchyma cells throughout the stem; rhaphide-sacs occasional. Starch often abundant in ground parenchyma.

Vascular bundle (the following refers to a central bundle, variation in its anatomy throughout its length is discussed in detail below): abruptly delimited from ground parenchyma by sheathing tissues. Phloem usually directed towards stem periphery, partly sheathed by fibers forming a well-developed fibrous phloem sheath. Fibers becoming sclerotic and conspicuously concentric-layered with age; lignification and wall thickening appearing first in innermost fibers closest to phloem and subsequently in centrifugal fibers. Conducting phloem tissue, often divided into two equal strands by a narrow sclerotic isthmus, including sieve tubes mostly 12–15μ wide, with compound sieve plates on slightly oblique to oblique end walls, irregularly scattered companion and phloem parenchyma cells, the former not well differentiated from the latter. Protophloem remains often recognized as an irregular group of sclerotic cells in the peripheral part of the sclerotic isthmus. Xylem enclosed by thin-walled, slightly lignified parenchyma less abruptly delimited from ground tissue than phloem sheath; rarely including a few fibers. Cells immediately surrounding vessels with wide pits and distinctly differentiated from remaining xylem parenchyma. Tracheal elements[3] including one or two metaxylem vessels 40–60μ wide, circular in transverse outline, and usually some narrow protoxylem elements. Protoxylem often separated from metaxylem by a narrow parenchymatous isthmus. Metaxylem vessel elements 600–800μ long with mostly scalariform perforation plates with few (4–10) thickening bars on oblique end walls; protoxylem either long imperforate tracheids with annular or helical wall thickenings or somewhat shorter vessels with unspecialized perforation plates transitional to metaxylem elements.

Variation throughout a single stem largely involves an increase in lignification with age. Stems vary much in vigor of growth and this is reflected in differences in diameter and length of internodes and total number of vascular bundles. Absolute measurements may be misleading, the best comparative unit is the internode. Differences between axes in juvenile and adult stages of growth have not yet been examined. The following paragraphs deal with overall distribution and types of vascular bundles in the adult mature stem; subsequently anatomical changes along vascular bundles are described.

COURSE OF VASCULAR BUNDLES IN THE STEM

Cinematographic analysis demonstrates that *all vascular bundles behave essentially alike* (FIG. 3). Major and minor bundles, with a continuous transitional series, differ in relative position in the stem and in the number of internodes between their successive branchings. Any one leaf is supplied by a larger number of minor and a smaller number of major bundles.

From the base to the apex essentially *all bundles maintain their individuality and proceed indefinitely up the stem.* Each of these *vertical*

[3] Protoxylem is distinguished from metaxylem entirely by its position and the nature of its elements. Developmental differences are not considered here.

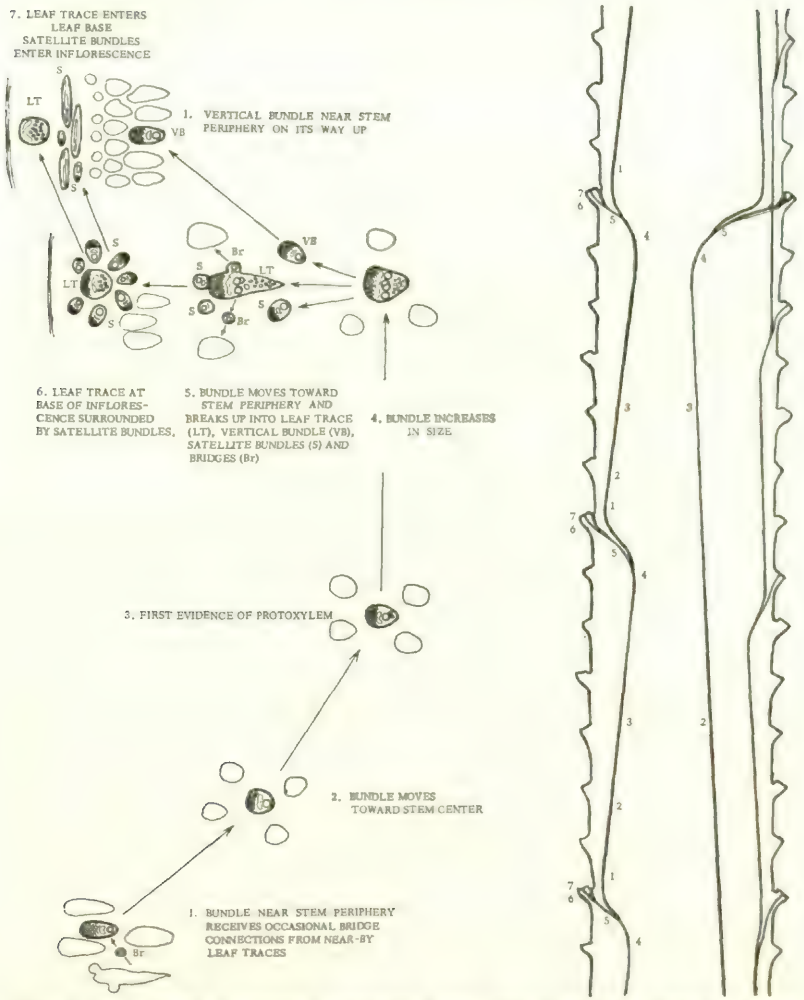
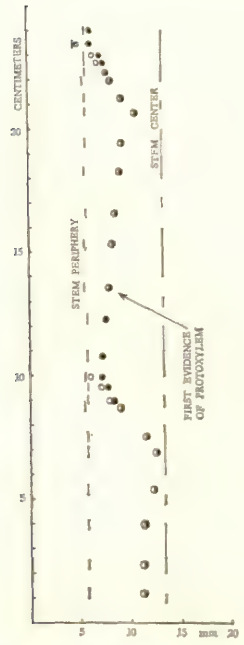

7. LEAF TRACE ENTERS LEAF BASE SATELLITE BUNDLES ENTER INFLORESCENCE
1. VERTICAL BUNDLE NEAR STEM PERIPHERY ON ITS WAY UP
6. LEAF TRACE AT BASE OF INFLORESCENCE SURROUNDED BY SATELLITE BUNDLES,
5. BUNDLE MOVES TOWARD STEM PERIPHERY AND BREAKS UP INTO LEAF TRACE (LT), VERTICAL BUNDLE (VB), SATELLITE BUNDLES (S) AND BRIDGES (Br)
4. BUNDLE INCREASES IN SIZE
3. FIRST EVIDENCE OF PROTOXYLEM
2. BUNDLE MOVES TOWARD STEM CENTER
1. BUNDLE NEAR STEM PERIPHERY RECEIVES OCCASIONAL BRIDGE CONNECTIONS FROM NEAR-BY LEAF TRACES

FIG. 3. The course of vascular bundles in the stem of *Rhapis excelsa*. In the diagram on the right the stem axis is foreshortened four times in relation to the stem diameter.

bundles gives off a *leaf trace* at intervals, the minor giving off leaf traces more frequently than the major bundles (FIG. 3, right). The overall course of the bundle is not a straight line. Each vertical bundle "moves" slowly towards the stem center. At intervals which vary according to its status, the bundle is "pulled out" sharply towards the periphery. Major bundles extend well into the stem center, minor bundles are "pulled out" before they reach very far toward the stem center (FIG. 3, right). The fact that only relatively few bundles reach the stem center, but all

bundles are at one time or another in the peripheral region, results in a considerable crowding of the peripheral stem area. This crowding is accentuated by the large fibrous sheaths of the bundles in this area (FIG. 7).

FIGURE 4 represents to scale, a bundle with a distance of 135 mm. between successive *leaf contacts*. Distances between leaf contacts are shorter in minor bundles, longer in major bundles. A major bundle was traced incompletely, but by extrapolation it was estimated that the distance between two successive leaf contacts was approximately 45 cm. The interval between successive leaf contacts is by no means uniform along a given bundle. Major bundles can become minor bundles and vice versa.



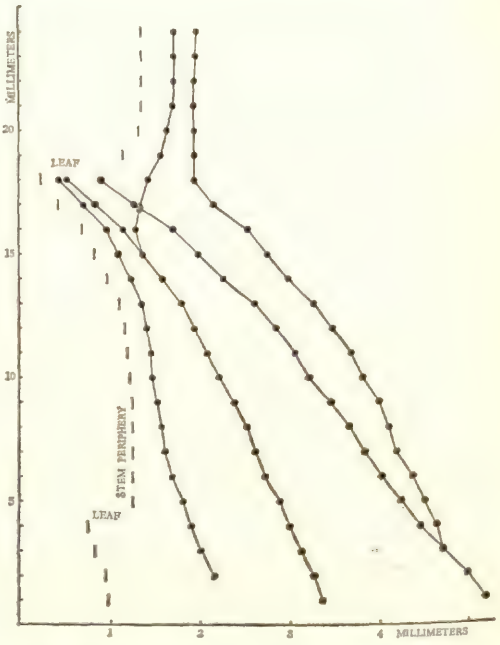


FIG. 4 (left). The course of a vascular bundle in the stem of *Rhapis*, drawn to scale. For convenience the stem axis is foreshortened four times in relation to the stem radius. Measurements were taken on the microtome sections after positions of the bundle had been secured with the aid of the analytical film and the drawings. Because there is no fixed reference point in the palm stem, outermost vertical bundles were taken as straight, and distances taken to the stem periphery (short vertical lines) and the measured bundle. Open circles indicate presence of protoxylem only; half-open circles indicate presence of both protoxylem and metaxylem; closed circles indicate presence of metaxylem only.

FIG. 5 (right). Diagram of a major, an intermediate, and a minor leaf trace to show spatial relationship to each other. Bridges and satellite bundles are not shown. Stem axis is foreshortened 3.6 times in relation to the stem radius. Measurements were taken as in FIG. 4.

A feature which cannot be indicated in FIGURE 3 is the shallow helix exhibited by all bundles in the central, uncrowded part of the stem. Traced upwards, all central bundles rotate uniformly in a clockwise direction, the steepness of the helix being such that each bundle rotates about ¼ of the stem circumference during a distance of about 15 cm. This helical path had been indicated by several earlier workers (e.g., Meneghini, 1836; Nägeli, 1858), but irregularly and only for single bundles. Ciné analysis shows it to be a uniform property of all bundles. It is quite obvious that if the distance between two successive leaf contacts of the same (major) vertical bundle is a little over 30 cm, this twisting brings the higher contact to the side of the stem opposite that which bears the lower contact (cf. Mirbel's diagram, FIG. 1B). If the path is still longer, the bundle may actually return to the original side of the stem. Monoyer's diagram of the upper part of the stem of *Arecastrum* (FIG. 2, right) may be simply the expression of either longer distances between leaf-trace intervals and/or a steeper helix.

DETAILS OF VASCULAR BUNDLE ANATOMY

FIGURE 5 shows three bundles drawn to scale, a major, a minor, and an intermediate one. It can be seen that the three traces enter the leaf at different angles. Therefore there is no distinct nodal plexus.

During the oblique outward curve, a bundle forks repeatedly (FIGS. 3, left; 6, 10, 11). The protoxylem-containing branch goes into the leaf as the leaf trace, the metaxylem-containing branches become respectively the continuation of the vertical bundle, *satellite bundles*, and *bridge bundles*. These four types of branches are discussed in the following paragraphs.

Leaf trace. This originates by gradual transformation of the vertical bundle in the following way. Following any vertical bundle upward in the stem, at a point about 10 cm. below the next leaf contact, the first evidence of protoxylem is reached (position 3 in FIG. 3). From this point upward the amount of protoxylem increases continuously. The bundle then reaches its maximum size (position 4, FIG. 3), turns sharply toward the stem periphery and breaks up into several branches. The whole of the metaxylem, but normally none of the protoxylem, passes into these branches. The protoxylem-containing bundle is the direct continuation of the vertical bundle and goes into the leaf as the leaf trace. This means that *there is no continuity of metaxylem between stem and leaf. The leaf is irrigated solely by protoxylem.*[4]

Vertical bundle. Ordinarily, the vertical bundle is the first branch to break off the leaf trace, shortly above the sharp outward turn. It then follows the leaf trace and near the stem periphery abruptly turns upward and continues its course up the stem, repeating the cycle (FIGS. 3–6).

In most cases a single vertical bundle arises from a trace plexus. Oc-

[4] See footnote 3, page 168.

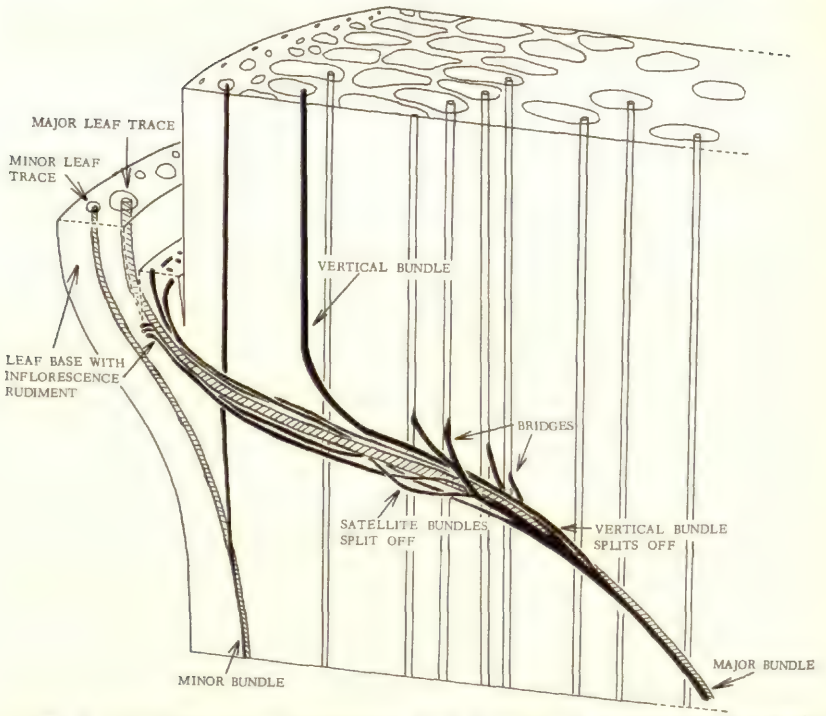


FIG. 6. Diagrammatic representation (not to scale) of the relation of a major leaf trace to its neighboring bundles. Stem axis foreshortened about four times in relation to stem radius. Metaxylem-containing bundles black, protoxylem-containing bundle cross-hatched, neighboring bundles white. The lines indicate direction and continuity of vascular tissue, they do not imply continuous vessels (see text p. 173). This figure represents stages 4–7 of FIG. 3.

casionally, however, none of the branches develops into a vertical bundle, in yet other cases two or even three vertical bundles may arise. This emphasizes the dynamic flexibility of the palm stem: the total number of bundles does not have to be exactly the same along the stem; in fact, it is certainly affected by environmental conditions. Whether the initial drastic increase in stem diameter from seedling to mature axis is due to this mechanism of "multiplying vertical branches" we do not know. Future investigation should answer this question.

Occasionally one can find a vertical bundle carrying not only metaxylem but also protoxylem. This indicates that the distance to its next higher leaf contact is less than 10 cm.

The very small fibrous bundles in the cortical area (FIG. 7) are vertical bundles from minor leaf traces. They become smaller, "move" towards the stem periphery (rather than towards the center) and end blindly further up the stem.

Bridge bundles. From each departing leaf trace, two to six bundles branch off and connect to vertical bundles in the neighborhood (FIG. 6).

Bridges are short, the longest one measured 4.5 mm. Occasionally they are so short that leaf trace and vertical bundle appear to fuse directly (Fig. 10). Bridges are always oriented obliquely upwards in the same way, so that the end of the bridge attached to the leaf trace is below the end attached to the vertical bundle.

Bridge bundles normally come directly off the leaf trace, but they also may break off a satellite bundle or even the vertical bundle. Occasionally a single bridge bundle breaks up into two branches which then connect to two vertical bundles (Fig. 6).

Physiologically, bridge bundles not only provide vertical vascular continuity via other vertical bundles, but they also provide extensive cross connections. Injection experiments in which dyes are introduced via petiole, root, or bore-hole in the stem, illustrate these lateral interconnections quite dramatically. In order to avoid any misunderstanding, we might point out here that by "vascular continuity" we do not mean continuity of individual vessels. Vessels are of limited length and overlap within any one bundle, just as they do within the xylem of a diffuse-porous dicotyledonous tree.

Satellite bundles. Several satellites branch from larger leaf traces in the region of bridge production (Figs. 3, left; 6, 11). Major traces produce up to 10 or more satellites; minor traces produce fewer or none, according to their size. Satellites accompany the trace to the periphery of the central cylinder. Some may "rotate" around the parent leaf trace and, in addition, may be inverted temporarily. They retain their individuality but may become temporarily enclosed within the fibrous sheath of the parent leaf trace or a nearby vertical bundle without making vascular connection. Ultimately they form a "halo" around the leaf trace (Fig. 3, position 6; Fig. 9). Immediately below the leaf base they turn abruptly and tangentially, and enter the inflorescence rudiment. It is obvious that satellites are best developed if a fully developed inflorescence is (or was) present. However, even inflorescences which had aborted very early in their development and are macroscopically not visible can be detected by their satellites, even in the lower "vegetative" part of the aërial stem (Fig. 8).

With a good deal of experience, one can often easily distinguish, in a single transverse section, vertical bundle, satellites, and bridges. However, this is not always possible, and one must follow the bundles upward in order to differentiate with certainty between the three types of branches that come off the leaf trace. One cannot help getting the impression that the three types, vertical bundles, satellites, and bridges, are developmentally equivalent. This problem will undoubtedly be met again, and hopefully be solved, when the apex is analyzed.

COMPARISON OF RHAPIS WITH OTHER MONOCOTYLEDONS

Our study of *Rhapis* has been carried out conjointly with the examination of a number of larger palms. The reason for this is quite obvious.

Our findings differ so fundamentally from the "classical" diagrams (cf. FIGS. 1 and 3) that the question arose as to whether we were dealing with an unusual object. Comparative studies have shown, however, that this is not the case. Whatever we have studied in other species has corresponded to *Rhapis,* although a great deal of work still remains to be done. We are now in a position to do it with the cinematographic method.

Literature search has revealed that the actual observations of former botanists do not differ from our findings. The way in which these early workers put together diagrams by extrapolation and inference proved misleading. Interestingly enough, good observers like Von Mohl, Karsten, etc. describe the limits of their work precisely. Distortions arose by the inaccurate citation of older authors, by frequent re-drawing of diagrams, and by the failure to distinguish what was observed from what was inferred.

Von Mohl's original diagrams (1824) were correct but incomplete. Those showing the blind ending of bundles in a basipetal direction (*Fig. VIII.2* in Tomlinson, 1961, p. 362) can be re-interpreted by assuming that Von Mohl's upper series were of a major bundle (Tomlinson's *Figs. 2a–f*) and the lower series were of a minor bundle (Tomlinson's *Figs. 2g–i*). This is very possible because Von Mohl merely drew a series of bundles from a single section and referred them to a hypothetical scheme. It was only subsequently (Von Mohl, 1849) that he considered the possibility of bundle fusions. This hypothetical suggestion was seized upon by later workers and incorporated in their diagrams (e.g., De Bary, 1877; our FIG. 1E). Branner (1884) is the only nineteenth century worker who fully understood the continuity of vascular bundles, simply because he was able to examine a great deal of material at first hand. He discovered that the continuity of vertical bundles was only evident when the apical regions were examined. Macrodissection suggested the blind ending of bundles because connections are tenuous and easily broken in mature parts of the stem. It is a remarkable feature of botanical history that Branner's very accurate work based on the careful examination of many palms in the field has been entirely overlooked in favor of wholly hypothetical schemes proposed by authors who had little opportunity of examining the problem at first hand.

While one of us (M.H.Z.) is interested in the vascular anatomy of palms from the point of view of long-distance translocation, the other (P.B.T.) approaches the subject as a systematic anatomist. The unravelling of the palm stem via *Rhapis* has given a much sounder theoretical background for an appreciation of certain features tentatively proposed as diagnostically significant (Tomlinson, 1961; cf. also Stenzel, 1904, where the important problem of identifying fossil palm stems is discussed in detail). Palms have been subdivided into three main categories dependent on the presence, in any small sample of the stem, of a majority of vascular bundles with either one, or two, or many vessels. A multi-

dimensional understanding of the palm stem explains this variability. We have seen in *Rhapis* that these three conditions represent successive stages repeated in the same sequence in all bundles over and over again. In *Rhapis* all bundles, traced from below upward and beginning a little above a leaf contact, show initially (Fig. 3, stage 1) one metaxylem vessel, except for areas in which two vessels within one bundle overlap, for example in bridge contacts. Continuing upward, however, the bundle then shows two vessels separated by a parenchymatous isthmus (somewhat below stage 4, Fig. 3). Finally (stages 4 and 5), prior and during the breaking up of the leaf-trace plexus, many metaxylem vessels are present. This increase in the number of vessels upward along a single bundle goes parallel with the increase in the amount of protoxylem.

Diagnostic significance can only be attached to a comparison of bundles of the same stage (preferably stage 1) of two species. Thus *Rhapis*, as well as *Ancistrophyllum*, *Areca*, *Borassus*, etc. (Tomlinson, 1961, p. 336) can be referred to as "one-vessel palms." "Two-vessel palms" can be recognized by protoxylem-free bundles which contain two vessels separated by a parenchymatous isthmus which indicates that the vessels are not merely overlapping ends. There may even be "many-vessel palms," but with the present state of our knowledge comment is not justified.

One great danger of using this difference in number of vessels per vascular bundle (of the stage 1) as a diagnostic feature lies in being satisfied that a small region of the stem is an adequate sample of the whole. In palms, there are considerable quantitative changes from base to apex of a single axis. It is quite conceivable that the same stem could be a "one-vessel" type basally, yet "two-vessel" distally.

The genus *Rhapis* cannot yet be compared easily with monocotyledons like *Zea* (e.g., Kumazawa, 1961) or *Tradescantia* (Scott and Priestley, 1925) which have a plexus of vascular tissue at each node. Non-nodal monocotyledons, however, may be similar, although few of these have been described in sufficient detail to merit comparison. An exception is *Alstroemeria aurantiaca* (Amaryllidaceae) analyzed by Priestley, Scott and Gillett (1935). This shows some of the basic features of the *Rhapis* type. Median leaf traces in *Alstroemeria* are derived from continuous vertical bundles, although this is not obvious because forking occurs many internodes below the node of exsertion. Forking of bundles many nodes below the level of their exsertion as leaf traces is illustrated in Falkenberg's diagrams of several monocotyledons intended as representative of the "palm type." But we know that the one palm (*Chamaedorea*) which Falkenberg claimed to have studied was analyzed incorrectly. We feel justified in being a little suspicious of Falkenberg's diagrams. *Rhapis* still has to be analyzed in terms of developmental physiology in the manner of Priestley and his associates. No doubt in the future many other monocotyledonous shoots will be better understood with the *Rhapis* stem as a model.

SUMMARY

The vascular anatomy of the mature, vegetative aërial axis of *Rhapis excelsa* (Thunb.) Henry is analyzed quantitatively by a cinematographic method. This involves photographing, frame by frame, either sequentially cut surfaces or serial sections stained and mounted permanently. The resulting film is analyzed in a data analyzer. All vascular bundles have essentially the same course and construction. In the uncrowded inner part of the stem they describe a uniform shallow helix continuously through the stem as vertical bundles, tending always toward the center of the stem. At intervals each turns sharply toward a leaf insertion and at the same time breaks up into several branches. The leaf trace proceeds into the leaf, satellite bundles go into the inflorescence, bridge bundles make vascular connection with neighboring bundles, and the vertical bundle continues its way up in the stem, repeating the whole cycle. There are minor, intermediate, and major bundles, the last reach farthest into the stem center and have the longest distances between successive leaf contacts.

ACKNOWLEDGMENTS

Routine serial sectioning on which this analysis is based was carried out by Lesley Jackson, Vroni Oswald, and Gabriel A. Vargo. We are indebted to them for their patience and perseverance with this tedious task.

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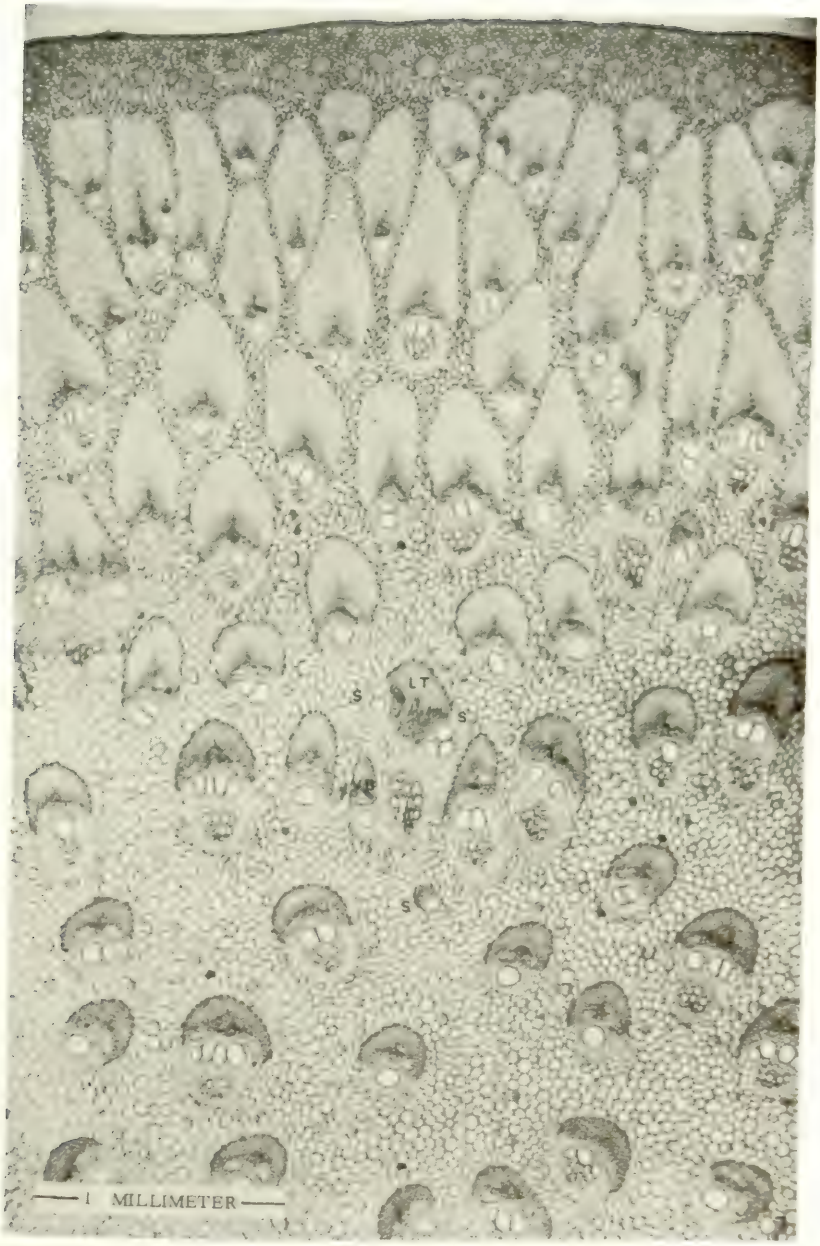
EXPLANATION OF PLATES

PLATE I

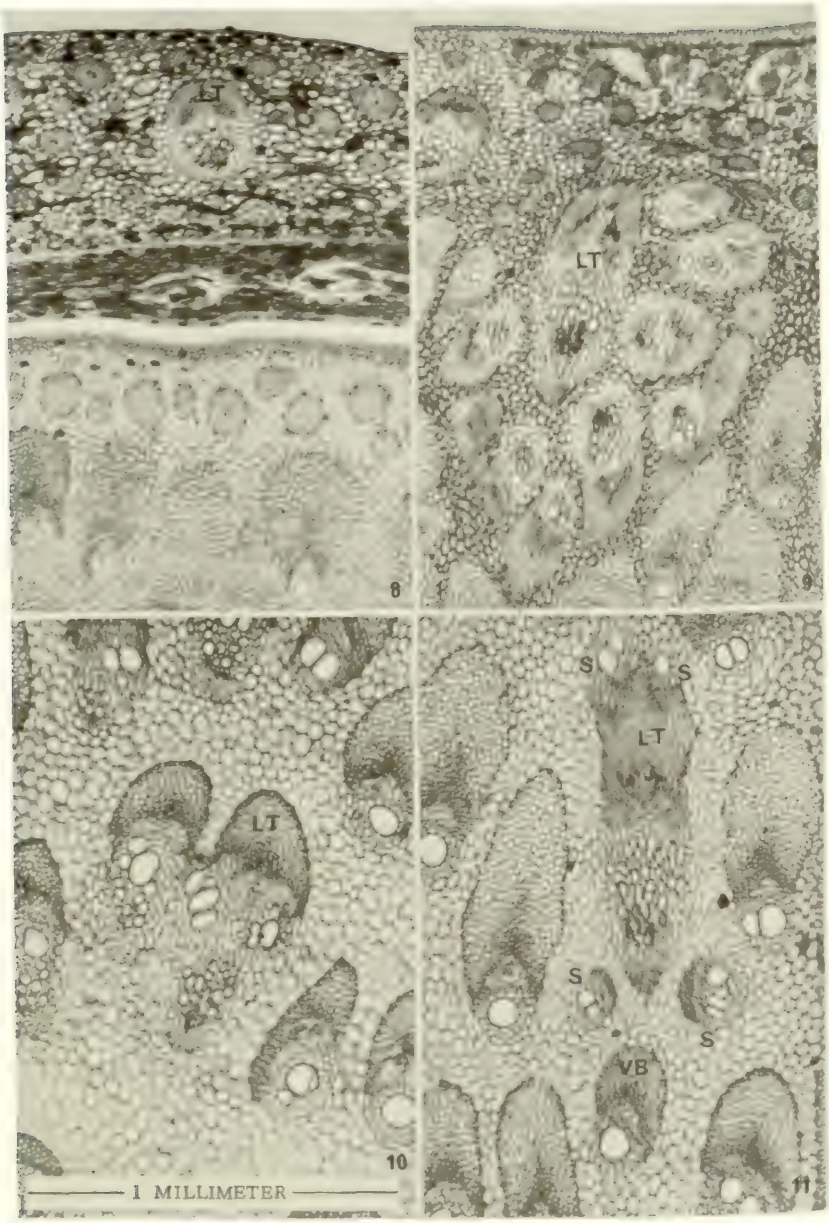
FIG. 7. A small section of the *Rhapis* stem showing crowding of bundles near the stem periphery. Near the center of the photograph a leaf-trace plexus consisting of leaf trace (LT), vertical bundle (VB), and satellite bundles (S). This corresponds to position 5, FIG. 3.

PLATE II

FIGS. 8–11. Transverse sections of stem of *Rhapis*; all magnifications identical. FIG. 8 (top left). A section at the level of the leaf base, corresponding to position 7, FIG. 3. The aborted inflorescence between stem and leaf. FIG. 9 (top right). A section just below the leaf base, corresponding to position 6, FIG. 3. The leaf trace (LT) is surrounded by a halo of satellite bundles. FIG. 10 (bottom left). A short bridge between a leaf trace (LT) and a neighboring vertical bundle. FIG. 11 (bottom right). A leaf-trace plexus consisting of leaf trace (LT), vertical bundle (VB) and satellite bundles (S). This photograph corresponds to position 5, FIG. 3.



ZIMMERMANN & TOMLINSON, THE PALM RHAPIS



ZIMMERMANN & TOMLINSON, THE PALM RHAPIS

STUDIES IN ALYSSUM: NEAR EASTERN REPRESENTATIVES AND THEIR ALLIES. II. SECTION MENIOCUS AND SECTION PSILONEMA

T. R. DUDLEY

A SYSTEMATIC SURVEY OF the genus *Alyssum* has long been needed, not only because it is the largest cruciferous genus in Turkey, accounting for approximately one fifth of the taxa of the Cruciferae in that area, but also because it has been the subject of some revisionary work (at least in the perennial species of sections ALYSSUM and ODONTARRHENA). The very extensive, and mostly unidentified Near Eastern collections of P. H. Davis, A. Huber-Morath, and K. H. Rechinger have added impetus to the need for a reassessment of morphological characters and variation, and a more stable definition of the specific and infraspecific taxa.

Previously, the only practical procedure for identifying *Alyssum* was to compare and contrast individual specimens with "correctly determined" herbarium material. The lack of conformity in treatments because of differing interpretations and divergent emphasis placed upon morphological characters is pointedly exemplified by the elaborate taxonomic hierarchies and extreme "splitting" of Fenzl in Tchihatcheff (1860), J. Baumgartner (1907–1911), and E. J. Nyárády (1926–1949). Taxa such as *Alyssum linifolium*, *A. alyssoides*, *A. minus*, *A. minutum*, *A. montanum*, *A. sibiricum*, *A. tortuosum*, *A. murale*, etc., having very wide geographical distributions are subject to considerable morphological variation within and between populations, as well as between individuals.

With the exception of section TETRADENIA, whose component species are not known to occur in Turkey, and section PSILONEMA which is represented in Turkey only by the widespread *Alyssum dasycarpum* (also possibly *A. alyssoides*, cf. page 199), more species (eighty-eight) and endemic species (forty-nine) are found in Turkey than in any other land area of comparable size. Of the seven species assigned to section MENIOCUS, six occur in Turkey, and of these three are endemics. These endemics (*A. blepharocarpum*, *A. stylare* and *A. huetii*) are characterized by a unique fruit indumentum of setae, found only in section MENIOCUS. The other species of this section having the same type of fruit indumentum is *A. heterotrichum* from Iran, Afghanistan, and a part of Kazakh S. S. R. The remaining three species of section MENIOCUS are glabrous-fruited. Of these, *A. aureum* and *A. meniocoides* have continuous distributions from southern Turkey to Syria, Lebanon, Palestine, Iraq, and Iran, while *A. linifolium* is one of the most widespread in the genus, extending from England (where it was probably introduced) throughout Europe and Asia, and east to India. It is probable that as Turkey has the largest

representation of species and endemics of section MENIOCUS, it has been the center of speciation for that section. Certainly, Turkey is the current center of diversity. On the other hand, this is not true for section PSILONEMA, of which only one species is known definitely to occur in Turkey. Whereas *Alyssum granatense* is found only in Spain and North Africa, *A. damascenum* and *A. homalocarpum,* although both Oriental species, are to be considered as Saharo-Sindian elements, and are not known from Turkey.

The widespread taxa *Alyssum linifolium* of section MENIOCUS, and *A. alyssoides* and *A. dasycarpum* of section PSILONEMA are characterized by a wide range of environmental tolerance. Such species as *A. aureum* and *A. meniocoides* which have more or less continuous distributions from Turkey into adjacent regions and are steppe-inhabiting or Irano-Turanian elements, are relatively limited by particular habitat preferences. This is also true for the Turkish endemics of section MENIOCUS, which although found in spatially open habitats, are characterized by a narrow range of environmental tolerance. All species of sections MENIOCUS and PSILONEMA are essentially calcicolous. This feature is particularly pronounced in Turkey where the species of section MENIOCUS are usually found on calcareous substrates, and is correlated with their preference for the steppe, the soils of which are primarily of limestone structure. The very widespread *A. linifolium* and *A. dasycarpum* attain their maximum development in the calcareous steppe and serpentine mountain screes, but tolerate and are relatively abundant in the saline steppe. Similarly, *A. blepharocarpum* is known to occur in the salt impregnated portions of the steppe which surrounds many lakes of the Turkish interior.

In this and succeeding papers, the strictly European or Asiatic species, which are most closely allied to those occurring in Turkey are included in the keys, and are treated systematically. However, these studies of *Alyssum* must be regarded primarily as a systematic revision of the Turkish species.

To assist in interpretation of the keys and descriptions, in this paper and in those to come, three plates showing the morphological diversity of petals, filaments, fruits, and trichomes are included. These plates illustrate only the major types of diversity of these structures throughout the genus. PLATES II and III show some of the diversity of the distinguishing floral and fruit characters. PLATE IV illustrates basic hair types which comprise the indumentum. These types are arranged more or less in a progressional sequence, from the simplest to the most complex. This does not imply, however, that one type necessarily evolved directly from any other. Many of the fruits pictured in PLATE III are normally covered with a characteristic indumentum (FIGS. a, c–g, j-o). This indumentum has been omitted in order that the fruit shape and configuration not be obscured. I am grateful to Dr. P. H. Davis, University Department of Botany, Edinburgh, Scotland, for permitting the use of these three plates, which were drawn for the forthcoming *Flora of Turkey* by Mrs. A. Dyer.

Included in this paper are keys to all currently recognized species assigned to sections MENIOCUS and PSILONEMA. In the main, all specimens seen have been cited, with the exception of the very widespread and common taxa, such as *Alyssum linifolium* or *A. alyssoides*. The specimen citations of these two species, as examples, from many areas in Europe could easily number several hundreds. In such cases I have cited only a few representative specimens; in most large herbaria, however, there will be found abundant additional material. Although I have omitted specimen citations for common European species, the citations of specimens of these taxa from the countries of the Near East are as complete as possible since floristic studies of the Near East are still in the explorative stages. This policy will be followed also in further papers on *Alyssum*.

The abbreviations for herbaria given by Lanjouw and Stafleu (eds.), Index Herbariorum, ed. 5 (Regnum Vegetabile 31. 1964) are used in this paper. Several not listed in an earlier paper (Jour. Arnold Arb. 45: 58. 60. 1964) are given here.

Herbarium of the Botanical Institute of the Academy of Sciences of the Kazakh S. S. R., Alma-Ata, U. S. S. R. (AA).
Laboratoire de Botanique de la Faculté des Sciences, Alger, Algérie (AL).
Botanisches Museum, Berlin-Dahlem, Germany (B).
Instituto Botánico de Barcelona, Barcelona, Spain (BC).
Istituto Botanico dell' Università, Bologna, Italy (BOLO).
Museum of Natural History, Department of Botany, Budapest, Hungary (BP).
Botanical Institute and Herbarium of J. E. Purkyně University, Brno, Czechoslovakia (BRNU).
Brigham Young University, Provo, Utah, U. S. A. (BRY).
Botanical Institute of the University of Coimbra, Coimbra, Portugal (COI).
Botanisches Institut der Karl-Marx Universität, Leipzig, Germany (LZ).
University Herbarium, University of Michigan, Ann Arbor, Michigan, U.S.A. (MICH).
The New England Botanical Club, Inc., Cambridge, Massachusetts, U. S. A. (NEBC).
Institutum botanicum Universitatis Carolinae, Praha, Czechoslovakia (PRC).

I would like to acknowledge with gratitude the valuable assistance of Dr. G. K. Brizicky for his translation of pertinent Russian literature and labels, and the editorial advice of Dr. B. G. Schubert.

I. Section MENIOCUS (Desvaux) Hooker

KEY TO ALL SPECIES OF SECTION MENIOCUS

A. Fruits glabrous, smooth, without setae or papillae.
  B. Seeds wingless; styles 0.1–0.5 mm. long; petals 1–2(–2.4) × 0.5 mm., pale yellow. . . . . 1. *A. linifolium*.
  B. Seeds winged (wings 0.1–0.4 mm. wide); styles 0.5–1.8 mm. long; petals (1.5–)2–6.5 × 1.5–2 mm., gold.
    C. Styles 0.5–1 mm. long; petals entire, (1.5–)2–3.5 mm. long; leaves ca. 1.5 mm. wide, ± conduplicate. . . . . 2. *A. meniocoides*.

C. Styles 1–1.8 mm. long; petals retuse or bilobed. 4–6.5 mm. long; leaves generally 2–4 mm. wide, always flat. ..... 3. *A. aureum.*

A. Fruits setose, at least on margins, and often papillose.

D. Styles more than 1.5 mm. long; petals deeply bilobed (sinuses 1.5–3.5 mm. deep), or retuse; sepals 2–3.5 mm. long.

E. Fruits elliptic, or obovate, (4–)5–7 mm. long, obtuse, setae (0.5–1 mm. long) and papillae always present and dense; seeds wingless; petals deeply bilobed. ..... 5. *A. stylare.*

E. Fruits orbicular or ovate, 3.5–5.5 mm. long, emarginate (rarely obtuse) or truncate, setae (0.2–0.5 mm. long) sparse on face of valves, or if only on margins then papillae always present; seeds winged, (wings 0.2–0.3 mm. wide); petals retuse. ..... 7. *A. blepharocarpum.*

D. Styles less than 1.5 mm. long; petals shallowly bilobed (sinuses 0.3–0.5 mm. deep) or emarginate; sepals 1–2 mm. long.

F. Petals shallowly bilobed, 2–4 mm. long; seeds winged (wings 0.1–0.2 mm. wide); sepals deciduous; leaves increasing in size upwards; fruits broadly elliptic to orbicular, obtuse or truncate; inflorescence spreading, more than 5 cm. long. ..... 4. *A. huetii.*

F. Petals emarginate, (0.7–)1–1.5 mm. long; seeds wingless; sepals ± persistent; leaves decreasing in size upwards; fruits narrowly elliptic or obovate, acute or attenuate; inflorescence compact and dense, 5 cm. or less. ..... A. *heterotrichum.*

1. **Alyssum linifolium** Steph. ex Willd. Linn. Sp. Pl. ed. 4. 3(1): 467. 1800(!). — Benth. Fl. Austral. 1: 71. 1863. — Boiss. Fl. Or. 1: 286. 1867. — Ruprecht, Fl. Caucasi. 105. 1869. — Willk. & Lange. Prodr. Fl. Hisp. 3: 834. 1880. — Brandza, Fl. Rom. 136. 1883. — Cosson, Comp. Fl. Atl. 2: 239. 1887. — Fedtschenko, Fl. Turkest. 1: 47. 1906. — Bornm. Verh. Zool.-Bot. Ges. Wien 60: 74. 1910. — Hayek, Prodr. Fl. Penin. Balc. 1: 437. 1925. — Jávorka & Csapody, Ic. Fl. Hung. *pl. 211, fig. 1589.* 1930. — Post & Dinsmore, Fl. Syr., Palest. & Sinai, ed. 2. 1: 89. 1932. — Krause, Ankaranin Floru 73. 1934. — Thiébaut, Fl. Lib.-Syr. 1: 72. 1936. — Heywood, Repert. Sp. Nov. 64(1): 54. 1961. — Quezel & Santa, Nouv. Fl. Algér. 1: 410. 1962. — Rech. Ark. Bot. 5(1): 169. 1963. — Dudley in Rech. Fl. Lowland Iraq 307. 1964. — Ball & Dudley in Flora Europaea 1: 299. 1964. Syntypes Crimea and Caucasus, Tauria et Armenia, *Stephan s.n.* (B, non vidi). Lectotype, Tauria, *Stephan s.n.* (B, non vidi); isolectotype (G-DC).

Annual, with many erect, ascending or rarely prostrate stems. *Leaves* linear and lanceolate (5–)8–10(–25) × (0.5–)1–2.5 mm.; the lower gradually attenuate, the upper short petiolate. *Sepals* 1.2–2 mm. long. *Petals* only slightly longer than sepals, 1.2–2.4 mm. long, emarginate, and pale yellow to whitish. *Long filaments* unidentate, 1–1.5 mm. long. *short filaments* 0.8–1.5 mm. long; appendages 0.3–0.4 mm. long. *Fruits* obovate or broadly elliptic, obtuse, 3.5–7 × 2–4.5 mm., glabrous; locules 4–6(–8)-ovulate. *Styles* 0.1–0.5 mm. long. $2n = 14–16$. *Fl.* Feb.–July. Two varieties are recognized.

A. Plant erect; stems stout, greenish; indumentum of stellate hairs with few and long rays; fruiting racemes elongate, multi-branched, 3–7 cm. long; leaves 10–25 × 1–2.5 mm. . . . . a. Var. *linifolium*.

A. Plant reduced; stems slender, grayish; indumentum of stellate hairs with few or many, short rays; fruiting racemes condensed, rarely branched, 1–3 cm. long; leaves 5–8 × 0.5–1.3 mm. . . . . b. Var. *teheranicum*.

a. Var. linifolium.

Meniocus serpyllifolium Desv. Jour. Bot. **3**: 173. 1814, *nomen nudum* — non *Alyssum serpyllifolium* Desf. 1798.

Alyssum linearifolium LaGasca, Gen. & Sp. Pl. 19. 1816. (!). Holotype, Spain, locis ardis prope Moxente oppidum Regni Valentini, *LaGasca 146* (MA, non vidi); isotype (G-DC).

Meniocus linifolius (Steph. ex Willd.) DC. Syst. Nat. **2**: 325. 1821 (!); DC. Prodr. **1**: 165. 1824. — Delessert, Ic. Select. Pl. **2**: 13. *tab. 42*. 1823. — Meyer in Ledebour, Fl. Alt. **3**: 45. 1831; in Ledebour, Fl. Ross. **1**: 134. 1842. — Mora, Fl. Fan. Esp. & Portugal **6**: 572. 1873. — Colmeiro, Pl. Penin. Hisp.-Lusit. 157. 1885. — Busch in Kuznet., Busch & Fomin, Fl. Cauc. Crit. **3**(4): 607. 1909; Fl. Sibir. & Orient. Extr. **6**: 558. 1931; in Fl. U.R.S.S. **8**: 359. 1939. — Cadevall & Sallent, Fl. Catal. **1**: 147. 1915. — Popov, Man. Fl. Tashkent, fasc. 1 & 2. *fig. 222*. 1923–1924. — Fedtschenko, Fl. Ross. Austro-Orient. **5**: 441. *pl. 389*. 1931. — Grossh. Fl. Kavk. ed. 2. **4**: 220. *tab. 25, fig. 7*. 1950. — I. V. Pavlov (Ed.), Fl. Kazakhstan **4**: 282. *tab. 35, fig. 12*. 1961.

Meniocus australasicus Turcz. Bull. Soc. Nat. Moscou **27**(2): 297. 1854 (!). Holotype, West Australia, Nova Hollandia, collection no. 4, *Drummond 127* (LE, non vidi); isotypes (BM, G, GH, K, OXF, W).

DISTRIBUTION AND HABITAT: a common and widespread weed of ruderal and cultivated lands, roadsides, vineyards, sandy and conglomerate hillsides, gravelly plains, steppe, Macchie, calcareous and gypsum outcrops throughout most of central, western, and southern Europe, North Africa, and the Middle East, Caucasia, and extending east to Afghanistan and Pakistan, and north to Siberia; alt. 50–2700 m. Naturalized and relatively common in New South Wales of Australia.

Spain. Valley of Segura, *Bourgeau 577* (E, G, GH, K, W); Cerros del Reagajal, nr. Aranjuez, 600 m., *Font Quer & Gros 26* (BM, E, G, GH, K, W); Prov. Teruel, Sierra de Valanche, *Reverchon s.n.* (E); Prov. Almeria, Muria, 1200 m., *Reverchon 851* (E, W); nr. Cazorla, 1200 m., *Reverchon s.n.* (W). **North Africa.** Oran, Plateau le Kreider, 1000 m., 17 Apr. 1911, *Faure* (E); Oran, *Warion s.n.* (E). **Russia.** Crimea, 1816, *Bieberstein* (G-DC); Tauria, 1820, *Steven* (G-DC); Crimea, *Busch s.n.* (W); Odessa, 1846, *Nordmann* (K); ibid., *Rehmann s.n.* (E) Podolia, 1820, *Andrezejowski* (G-DC); Podolia, *Besser s.n.* (K, W); Illyria, *Willdenow s.n.* (G-DC); Russian Armenia, Talin, Karmrashen (Karaburun)-Ashnak, 9 June 1959, *Aslanian & Karpaetian* (W); Mt. Bogutli, nr. Alages (Aragots), *Lagowski s.n.* (GH); Caucasus, *Callier 539* (BM, K, W); ibid., *Callier 4211. 258* (G); Daghestan, 1874, *Becker* (K, W); Azerbaidjan, *Pichler 150* (G); Transcaucasus, *Holmberg 533* (W); ibid., 800 m., 1888, *Conrath* (G); Tanaim, *Goldberg s.n.* (G-DC); Nachitschevan, Dzhulfa-Darosnan, 3 May 1934, *Karjagin* (A); ibid., nr. Aliablast, 13 May 1934, *Grossheim & Gurvitsh* (K); Georgian Caucasus,

1831, *Hohenacker* (BM, K, W); ibid., 1838, *Hohenacker* (G, K, W); Achabzich, *Radde 412* (K); Prov. Elisabethpol, nr. Elisabethpol, Apr. 1900, *Fedossejew* (A, G, W); Prov. Fergana, dist. Kokand, S. of Kanibadam, 1913, *Minkwitz* (GH); Kurtuk, Kurtu river, 12 May 1930, *Serowa & Ryschowa* (A); Kirghiz S. S. R., Prov. Semirechensk, dist. Pishpek, Atbashansk, Chu river, *Tsintserling* (A, GH); Siberia, Suddagh, *Pallas s.n.* (BM); Uskut, *Pallas s.n.* (BM); Dauria, nr. Astracan, 1819, *Fischer* (G–DC); ibid., 1828, *Prestcott* (K); Songarei, 1831, *Schrenk* (G, GH, W); Siberia, 1819, *Sprengel* (G–DC); Catherinoslavo, Borysthenes nr. Alexandrovsk, 1865, *Grüner* (BM); Altai, *Ledebour 329 & Meyer 46* (W). **Romania.** Basarabia, dist. Ismail, nr. Satu, 2–10 m., *Borza 654* (E). **Turkey.** A3: Prov. Ankara, NW. of Beypazari-Nallihan, *Kühne 395* (STU); Kirzbepe, *Kühne 730* (STU). A4: Prov. Kastamonu, Seker-Köprü (Kure-Kastamonu), 1892, *Sintenis 3773* (G, K, W). A5: Prov. Amasya, Amasya, 400–600 m., 1889, *Bornmüller 1340* (E, K, W). A6: Prov. Tokat, Tokat, 600–700 m., 1893, *Bornmüller 3244* (G, K, W). A7: Prov. Gümüşane, Bayburt-Gümüşane, 1700 m., *Stainton 8222* (E). A8: Prov. Gümüşane, Gümüşane, *Bourgeau 39* (W). A9: Prov. Kars, Kağizman-Tuzluca, *Sauer 269* (E, ISTF); Tusuz, 1800 m., *Davis 29576* (A, BM, E, K). A/B8: Prov. Erzurum/Gümüşane, Bayburt-Erzurum, 1853, *Huet* (E, G). B1: Prov. Manisa, Sipyli (Manisadağ), 700–900 m., *Bornmüller 9070* (G, W). B2: Prov. Uşak, Ouchak (Uşak), 910–940 m., *Balansa 1251* (BM, E, G, GH, K, W). B3; Prov. Eskisehir, Eskisehir, *Turkish Sugar Co. 475, 477* (BM, E); Prov. Afyonkarahissar, dist. Emirdağ-Bolvadin, 10 km. S. of Emirdağ, 1100 m., *Huber-Morath 13726* (E, HM). B4: Prov. Ankara, Ankara nr. Judyie, 385 m., 1929, *Bornmüller 13853* (BM, G); Ankara, *Frères E. C. 244* (G); 13 Apr. 1958, *Kühne* (STU); *Merton 3279, 3286* (E, K); *Görz 15* (BM, G); Prov. Konya, Yavşan Memlehasi nr. Tuz gölü, *Davis 18691, 31807* (BM, E, K); Prov. Niğde/Konya, 4 km. from Halkenli köy, W. side of Tuz gölü, 1000 m., *Dudley, D. 35928* (E). B5: Prov. Kayseri, plaine de Césarée (Kayseri), 1107 m., *Balansa 990* (E, G, GH, K, W). B6: Prov. Maraş, Elbistan, 1500 m., *Davis 27642* (A, BM, E, K). B7: Prov. Elâziğ, Egin (Kemaliye), June 1853, *Huet* (G, W). B8: Prov. Erzurum, Erzurum, June 1853, *Huet* (G); *Zohrab 376* (K). C2: Prov. Antalya, Elmali-Korkuteli, 5 miles from Elmali, 1120 m., *Dudley, D. 35211* (E). C3: Prov. Burdur, Burdur, May 1845, *Heldreich* (BM, E, K, G, W); Prov. Konya, Konya-Beyşehir, 4 km. from Beypazari, *Dudley, D. 35840* (E). C4: Prov. Konya, Konya-Sultanhani, 18 miles from Konya, 1050 m., *Dudley, D. 35918a* (A, E); Çumra distr., Kücük köy, *Helbaek 2557* (E); Niğde, Ala dağ, nr. Çukur dağ, 1900–2060 m., *Parry 64* (E). Additional Turkish specimens: *Huber-Morath 10990, 12817, 13721, 13724, 14803* (HM); *Dudley, D. 35957, D. 35840* (E); Caria, *Kirk s.n.* (E); Lycia, Sorkoon (?), *Forbes 48* (K); Armenia, *Szowits s.n.* (G, GH, K, W); 1867, *Calvert & Zohrab* (E, G, K); *idem 45, p.p.* (OXF). **Syria.** Quaryatein, *Davis 5726B, 5602* (E, K); Quaryatein-Rat Tush, *Davis 5634* (E, K); *Russell s. n.* (BM, G–DC). **Palestine.** Wadi Musa-Moan (Transjordan), 1219 m., *Davis 8691* (E, K); Plaine de Amalites, Apr.–May 1846, *Boissier* (G); Ain-Musa, 16 Apr. 1929, *Eig et al.* (G, W); 20 km. S. of Moan, 18 Apr. 1923, *idem* (G, W); Wadi Hasá-Ain Musa, 17 Apr. 1929, *idem* (G, W); Kal. Hasa-Kal. Anezé, 17 Apr. 1929, *idem* (G, W). Syria/Iraq. Aleppo-Mosul, *Oliver s.n.* (G–DC). **Iraq.** Baqubak, *Rogers 45, p.p.* (K); Jarmo, *Helbaek 306* (K); Jazira, 20 km. NW. of Falija, *Guest & Rawi 13649* (K); Mosul-Kirkuh, *Guest 625* (K); Karbala liwa, ca. 15 km. W. of Karbala, *Gillett & Rawi 6375* (K); 18 km. S. of Rutba, 640 m., *Rawi 14634* (K); Thukhaib, 280 m., *Rawi 14795* (K); 50 km. E. of Samarra, Asila, 10 km. N. of Shaikh

Mohamma, 50 m., *Rawi 20480* (K); ibid., *Rechinger 13452* (W); 4 km. E. of Samarra, 65 m., *Rawi 20329* (K); ibid., *Rechinger 13500* (W); Truleal-e-Has, *Rechinger 4330* (W); Mesopotamian desert, 15 Sept. 1919, *Watson* (K); Oguhah, *Graham 25* (BM); Euphrates, Meskare-Der-es-Sor, Sabcha-Tibne, 250–350 m., *Handel-Mazzetti 542* (W); Kaijum-Abukenal, 120–180 m., *Handel-Mazzetti 652* (W); Mejadin-Salbije, 180 m., *Handel-Mazzetti 632* (W); Assyria, Kerkcik, 1893, *Bornmüller 894* (G); Jabal Hamrun, Muqdadija (Sharaban)-Jalaula, *Rechinger 14212* (W). **Iran.** Prov. Khorasan, Turbat-e-Haidari, 1300 m., *Rechinger 4346* (G, W); ibid., ca. 30 km. from Meshhed, *Rechinger 1502* (W); Mt. Kopet Dagh, nr. Alamli, 2000 m., *Rechinger 4670, p.p.* (W); Djenaran-Kucan, *Rechinger 7519, p.p.* (W); Schiras-Kamareyi, 200–600 m., Apr. 1868, *Haussknecht* (BM, G); Sultanabad nr. Kaswin, 1524 m., *Lindsay 29, 32* (BM); Transcaspian, 1900, *Sintenis 165* (G, K, W); 10 km. E. of Zorab, 1667 m., *Cowan & Darlington 1615* (K); Prov. Hamadan, Kharaghan (Hamadan), *Sabeti 94* (W); Faghire nr. Hamadan, *Sabeti 225* (W); Aq Bulaq, ca. 100 km. N. of Hamadan, *Rioux & Golvan 210, 213* (W); Mt. Elburs, Demawend, 2640 m., 22 July 1936, *Gilli* (W); Keredj, *Rechinger 526* (W); ibid., 27 Apr. 1934, *Gauba* (W); Mazanderan, Bashm Kuh (Shahmirzad), N. of Baslm, 2700 m., *Wendelbo 1341* (BG, E); Haraz valley, W. of Siah Bisheh, 700 m., *Wendelbo 428b* (BG, E); Bakhtiari, Oregon, Damane-Kuh, 2300 m., *Wendelbo 1727* (BG, E); Kerman, Kerman-Saidabad (Sirdjan), Mashiz-Khan-e-Sorck, 2000–2580 m., *Rechinger 3051* (E, G, K, W); Mt. Djamal Bariz, Bam-Djiroft, Deh Bakri, 2100 m., *Rechinger 3805* (G, K, W); Rescht-Teheran, Ruiobar-Mendschel, 300–400 m., 1902, *Bornmüller 6243* (G). **Kuweit.** Shaiba, 23 Aug. 1919, *Watson & Sharples* (K). **Afghanistan.** Hari-rud valley, *Aitchison 160, 430,* (GH, K); Istalif, 1800–1840 m., *Gilli 1087, p.p.; 1088* (W); Kamardtal, W. of Duab, 1630 m., *Gilli 1078* (W); Prov. Kabul, Chord Kabul, E. of Kabul, 2280 m., *Gilli 1090* (W); Koh-i-Asmir, 1900 m., *Wendelbo 2733* (BG); ca. 15 km. W. of Sarobi, 1100 m., *Wendelbo 2791* (BG); Sarobi, *Volk 2454* (W); 20 km. E. of Lataband, 1800 m., *Wendelbo 3022* (BG); Qual-e-Eslan, 25 km. S. of Kabul, 1830 m., *Wendelbo 3204* (BG). **Pakistan.** North-West Frontier, Parachinar, Kurram Valley, 2134 m., *Stewart 28117* (MICH); *Stewart 14738* (K); Peshin, 1550 m., *Lace 3308* (E, K); Murqudochen, *Stokes 942* (K).

Specimens intermediate between the two varieties are known to occur in Afghanistan: Otipore, Chokey and Korobat, *Griffith 1519*, ex hb. Lehmann (K); *Griffith 1415* (GH).

Alyssum linifolium is one of the most widespread species in the genus, and is quite variable in the size of its leaves and fruits, and in its stature. However, with the exception of the variety which follows (var. *teheranicum*), the minor variations do not warrant nomenclatural recognition. One interesting variation occurs on plants (e.g. *Davis 18691* and *Dudley, D. 35928*) growing in extreme saline habitats. The leaves of these plants are very narrow and conduplicate, resembling those of *A. meniocoides*. This character, however, is not constant, for the plants assume a normal appearance immediately outside the salt areas.

The closest allies of *Alyssum linifolium* are *A. meniocoides* and *A. aureum*, both of section MENIOCUS. From these, *A. linifolium* may be easily distinguished by its wingless seeds, much shorter styles, and smaller floral parts.

Professor Zohary (Palest. Jour. Bot. Jer. ser. 2(2/3): 162. 1941) maintains that *Alyssum minimum* L. (Sp. Pl. 2: 651. 1753) is the correct binomial for this species, and that *A. linifolium* is a synonym. Examination of Linnaeus's specimen of *A. minimum* (LINN. 828:8) proves without any doubt that this is not the case; *A. minimum* L. can only be treated as a synonym of *Lobularia maritima* (L.) Desv. (Basionym: *Clypeola maritima* L. Sp. Pl. 2: 652. 1753). *A. minimum* sensu Willd. (Willd. Linn. Sp. Pl. ed. 4. 3(1): 464. 1800) clearly is not the same taxon as *A. minimum* L., but may be identified rather as *A. desertorum* Stapf.

b. Var. **teheranicum** Bornm. Bull. Herb. Boiss. II. 4: 1269. 1904 (!). — Parsa, Fl. Iran 1: 746. 1952. Holotype, Iran, in vallis oppidi Teheran, 1150 m., 20 Feb. 1892, *Bornmüller 2155* (B, non vidi); isotypes (BM, E, G, K, OXF, W).

Alyssum (*Meniocus*) *cupreum* Freyn & Sint. Bull. Herb. Boiss. II. 3: 695. 1903 (!). — Fedtschenko, Fl. Turkest. 1: 47. 1906. Holotype, Russia, Regio Transcaspica, Krasnowodsk in arenosis montium, 17 Mar. 1900, *Sintenis 18* (BRNU, non vidi); isotypes (BM, E, G, K, W).

Meniocus linifolius f. *microcarpus* Busch in Kuznet., Busch & Fomin, Fl. Cauc. Crit. 3(4): 610. 1909. Holotype, Russian Armenia, in tractu Bortschalo in Somchetia, 1837, *Koch 143* (LE, non vidi).

Alyssum linifolium var. *cupreum* (Freyn & Sint.) Dudley in Hedge, Årbok Univ. Bergen, Mat.-Naturv. No. 13: 6. 1963 (!).

DISTRIBUTION AND HABITAT: scattered in extreme steppic conditions, loose gravel, dry limestone hillsides, desert, and serpentine substrates of Turkey, Syria, Iraq, Iran, Caucasia, Azerbaidjan, Afghanistan and Pakistan; alt. 200–2000 m.

Turkey. A2 (E): Prov. Istanbul, Rumel Hissar, 16 May 1915, *Post* (G). A4: Prov. Ankara, Çubuk, 1000 m., *Markgraf* (Z). B4: Prov. Ankara, 7 Apr. 1958, *Kühne* (STU). C4: Prov. Konya, Agios Philippos (Hagios Philibos), *Post 15* (G). C5: Prov. Niğde/Adana, Ulukişla-Pozanti, 900 m., *Davis 26300* (BM, E, K). Cappadocia, 1834, *Montbret* (K). Asia Minor, *Aucher 280* (G, K); ibid., *Aucher 4100* (BM, G, K, W). **Syria.** Palmyra, 200 m., *Dinsmore 22497* (K). **Iraq.** Dist. Kiruk (Kurdistan), ad confines Persiae, Khanaquin, *Rechinger 14128* (W); Mosul, 200 m., *Bugloss 8* (K). **Iran.** Prov. Teheran, Kishlak (Garmsar), Seman-Teheran, 900 m., *Rechinger 2773b* (W); nr. Teheran, 1220 m., 1892, *Bornmüller 2154* (E, G, K, W); ibid., *Schmid 5102* (G); Kom, 1892, *Bornmüller 2153* (G); Chononsar, 1900 m., 1892, *Bornmüller 2151* (G, K, W); *Bornmüller 2156* (BM, E, G, K, OXF, W); Teheran-Davudieh hills, 1400 m., *Wendelbo 97a* (BG, E); Persepolis, *Kotschy 1053* (G, W); S. of Tabriz, *Gilliat-Smith 1351, 1352, 1336, 1338* (K); 39 km. W. of Kermanshah, 1372 m., *Cowan & Darlington 2618* (K); Shershah, Mar. 1859, *Bunge* (G, K); Kerind, *Evans 37* (E); Prov. Kazvin, Keredj, nr. Kalak, 1600 m., *Rechinger 2745* (G, W); Mt. Elburs, Keredj-Kalak, *Rechinger 143* (W); Prov. Isfahan, Kuh Pah, 1700 m., *Rechinger 2714* (W); Abadeh-Daulatabad, 1500–2000 m., *Schmid 5313, 5318* (G); Fars, Takht-i-Jamshed, *Koelz 14420* (E, W); Prov. Khorasan, Robat Safid, 1800–2000 m., *Rechinger 7335* (W); Mazanderan, Haraz valley above Panjab, 1300 m., *Wendelbo 303* (BG, E); Prov. Baluchistan, Khash (Vasht)-Iranshahr

(Bampur). Mt. Karvandar, 1500–1600 m., *Rechinger 3958* (W). **Russia.** Azerbaidjan, Zelizabethpol (Elizavetpol), 1882, *Pichler* (G, GH, W); Krasnowodsk, 1900, *Sintenis 17* (E, G, K); 1900, *Sintenis 19* (G). **Afghanistan.** Kabul-Paghman, 1880–1910 m., *Gilli 1089a, 1089b* (W); Kabul, Scher Darwasah, 1790–1840 m., *Gilli 1081, 1082, 1083, 1085* (W); ibid., *Neubauer 537* (W); ibid., Koh-e-Tschelsotun, 1810 m., *Gilli 1084* (W); Kabul, *Gilli 1091* (W); E. of Kabul, Budchak, 1770 m., *Gilli 1080* (W); Dschmal Baba, S. of Kandahar, 1000 m., *Gilli 1077* (W); Kodananebene-Istalif, 1750 m., *Gilli 1079* (W); Istalif, 1800 m., *Gilli 1087, p.p.* (W); Sarobi, *Volk 2455, p.p.* (W); Pule Surkh nr. Tsharikar, *Neubauer 542* (W); nr. Kabul, NW. of Aliabader Mt., 1800 m., *Gilli 1086* (W); ibid., *Collett 12* (K). **West Pakistan.** Quelta, Kitta Aboulla, *Duthie 8577, 8578* (G, K).

The differential characters of *Alyssum linifolium* var. *teheranicum* are consistent in small and scattered populations throughout the southeastern range of the species. The type specimens of var. *teheranicum* are morphologically identical to those of *A. cupreum*, the latter name is, therefore, placed in synonymy. Bornmüller used yet another varietal name for this taxon in *exsiccatae*, but without a Latin description. This epithet referred to the dense, metallic-colored indumentum.

2. **Alyssum meniocoides** Boiss. Ann. Sci. Nat. Paris II. 17: 158. 1842 (!). — Boiss. Fl. Or. 1: 286. 1867. — Handel-Mazzetti, Ann. Naturh. Mus. Wien 27: 52. 1913. — Boul. Fl. Liban. & Syr. 32. *pl. 38, fig. 11.* 1930. — Post & Dinsmore, Fl. Syr., Palest. & Sinai, ed. 2. 1: 89. 1932. — Thiébaut, Fl. Lib.-Syr. 1: 72. 1936. — Parsa, Fl. Iran 1: 747. *fig. 621.* 1952. — Rech. Ark. Bot. 5(1): 170. 1963. — Dudley in Rech. Fl. Lowland Iraq 307. 1964. Holotype, Mesopotamia, *Aucher 281* (G); isotypes (BM, K, OXF).

Meniocus filifolius Jaub. & Spach, Ill. Pl. Or. 1: 107. *tab. 53B.* 1843 (!), non *Alyssum filifolium* Wahlenberg, 1826. (Cf. Dudley, Jour. Arnold Arb. 45(3): 372. 1964). Holotype, *Aucher 281* (P, non vidi); isotypes (BM, G [holotype of *A. meniocoides*], K, OXF).

Alyssum tetraspermum Bertol. Miscell. Bot. 2: 12. 1843 (!). Holotype, Turkey, C6: Euphrates, ex campis ad Portum William (S. of Birecik), Mar. 1836, *Chesney 25* (BOLO, non vidi); isotypes (BM, G, K).

Alyssum kermanshahensis Cowan ex Parsa, Fl. Iran 1: 733. *fig. 607.* 1952 (!). Holotype, Persia, 39 miles E. of Kermanshah, 1372 m., 29 Mar. 1929, *Cowan & Darlington 354* (K).

Annual, stems slender, 3–10 cm. tall. *Leaves* (5.5–)10–18 mm. long, ± conduplicate. *Petals* obovate, entire, (1.5–)2–3.5 mm. long. *Long filaments* 1.5–2 mm. long, terminated with bifid apices 0.3–0.4(–0.5) mm. long. *Short filaments* 1–1.5 mm. long, with always bifid appendages 0.5–1 mm. long. *Fruits* glabrous. *Styles* 0.5–1 mm. long. *Seed wings* 0.1–0.2 mm. wide. *Fl.* Feb.–Apr.

DISTRIBUTION AND HABITAT: fallow fields, steppe, limestone slopes, and sometimes associated with *Quercus aegilops* forests in Mesopotamia of

southeastern Turkey, the Syrian desert, Lebanon, Palestine, Iraq, Iran, and Afghanistan; alt. 100–2000 m.

Turkey. C6: Prov. Gaziantep, Aintab (Gaziantep), Apr. 1886, *Shepard* (GH, K); 10 Apr. 1884, *Post* (BM); Yonas, Euphrates, 25 km. E. of Gaziantep, 914 m., *Haradjian 1770a* (E, G, K, W); Bal Zus (Balkis) nr. Birecik, 1200 m., *Haradjian 1043* (G, W); Merza nr. Birecik, 1888, *Sintenis 131* (BM, E, G, K, W); Prov. Hatay, Amurk nr. Hassa, Amanus dağ-Kurt dağ, *Haradjian 889* (G, W). C7: Prov. Gaziantep, Rum Kala (Halfeti), 1888, *Sintenis 157*, approaching *A. aureum* (BM, E, G, K, W); Prov. Urfa, Djebel Taktak (Tektek dağ) Apr. 1867, *Haussknecht* (BM, K, W). C8: Prov. Mardin, Mardin, 1894, *Post* (BM, G). **Syria.** Isiayah, 1 Apr.–1 May 1900, *Post* (BM, G); Nebk, *Davis 5528*, approaching *A. aureum* (E, K); Dayr-'Atiyyah, *Post* (BM); ibid., 1200 m., *Post 13815* (E, G, K); ibid., May 1879, *Post* (BM); Aleppo, *Russell s.n.* (BM); ibid., *Lesier 452* (E); ibid., June 1867, *Haussknecht* (G, W); Turmanin nr. Aleppo, 1865, *Haussknecht*, *p.p.* with *A. aureum* (G, W); Jabul-Gourn, 950 m., *Dinsmore 19815* (G, K); Palmyra, 400 m., *Dinsmore 20497* (K); ibid., Snoi-Teida, Djebel Abour, *Blanche 2887* (G); Damascus, Apr. 1928, *Druce* (OXF); ibid., 14 Apr. 1894, *Péronin* (G); ibid., Djebel Kharbi, *Gaillardot 1546* (G); ibid., Sasoa-Kisive, 671 m., Feb. 1945, *Norris* (BM); 10–15 km. from Damascus, 503–914 m., 4 Mar. 1945, *Norris* (BM); nr. Baalbak, 12 Mar. 1867, *Fox* (K); Horms-Hama, 2000 m., *Haradjian 4099* (G); Armel Wir'al-Am'El Beidha, 8 Apr. 1890, *Post* (BM). **Palestine.** Busrah-Kurayyah, 900 m., *Dinsmore 2460*, approaching *A. aureum* (G, K); Moab-Qual'at Ziza, *Feinbrun & Zohary 327* (BM, E, G, GH, K, W); Amman-Ziza, 15 Apr. 1929, *Eig et al.* (G, W); Ziza, 700 m., *Dinsmore 11815* (E, G, K); Es-Salt-'Amman, Apr. 1895, *Post* (G); Umel Ammud, 15 Apr. 1929, *Eig et al.* (G, W). **Lebanon.** Wadi Karn, Yabrud (Zebrad), *Post 88* (G); Zeferya-Beyrout, 21 May 1881, *Péronin* (G); Beyrout plain, 100 m., *Maitland 70* (K). **Iraq.** Zawita, Mosul liwa, *Polunin et al. 47* (BM, E, G, GH, K); Hieropolis, Mar. 1867, *Haussknecht*, *p.p.* with *A. aureum* (G, K, W); Euphrates, Abu Herera, Meskene-Der-es-Sor, 205–350 m., *Handel-Mazzetti 424*, approaching *A. aureum* (W); Tuz Khurmatli, *Rogers 349* (K); Kirkuh, *Rogers 74* (K); Duleam liwa, 6 km. above Ana, 130 m., *Gillett & Rawi 6967* (K); Erbil liwa, Slahaddin, 1000 m., *idem 10423* (K); Suleimaniya liwa, Givija forest, 1100 m., *idem 10623* (K); L'Alders, 1919, *Hanna* (BM). **Iran.** Teheran, Davudieh hills, 1400 m., *Wendelbo 97b* (BG, E); distr. Kermanshah, Qualapoin, 22 km. E. of Kermanshah, 1280 m., *Bent & Wright 112*, *p.p.*, *125*, *p.p.* (W); 39 miles E. of Kermanshah, 1372 m., *Cowan & Darlington 256* (K); Prov. Luristan, Durud, Koelz 17103 (E, MICH, W); Teheran, Farahabad, *Sabeti 182* (W); nr. Kaswin (Mazraeh), 1200 m., *Schmid 5050*, *5045* (G); ibid., *Schmid 5055* (W); ibid., *Stutz 711* (BRY, W). **Afghanistan.** Obeh, 1700 m., *Koie 3782* (W); Prov. Bamian, Danak Siakr, 10 km. from Doab, 1500 m., *Wendelbo 3418* (BG, E).

In collections containing both *Alyssum meniocoides* and *A. aureum* in Mesopotamia, the diagnostic characters of each remain quite clear, and *A. aureum* is still flowering when *A. meniocoides* has mature fruit. Although both species occasionally occur in the same population, neither has any apparent ecological or altitudinal preferences; however, *A. aureum* replaces *A. meniocoides* in central and eastern Anatolia. The petals of some specimens (e.g. *Sintenis 131 & 157*) approach in size those of *A. aureum*; likewise the leaves of these specimens are somewhat atypical

and more or less resemble those of *A. aureum*. In all other respects, however, these plants possess all the other characters of *A. meniocoides*. Collectors have frequently confused *A. meniocoides* with *A. linifolium*, which occurs commonly throughout the same geographical areas, but the former has winged seeds, longer styles, larger floral parts, and generally narrower and conduplicate leaves.

3. **Alyssum aureum** (Fenzl) Boiss. Fl. Or. 1: 286. 1867 (!). — Boul. Fl. Liban. & Syr. 32. 1930. — Post & Dinsmore, Fl. Syr., Palest. & Sinai, ed. 2. 1: 89. 1932. — Thiébaut, Fl. Lib.-Syr. 1: 72. 1936. — Rech. Ark. Bot. **5**(1): 166. 1963.

Meniocus aureus Fenzl, Pug. Pl. Nov. Syr. & Taur. Occid. 1: 13. 1842 (!). Holotype, Syria, circa Aleppo, 22 Mar. 1841, *Kotschy 27* (W); isotypes (BM, E, G, GH, K, OXF).

Meniocus grandiflorus Jaub. & Spach, Ill. Pl. Or. 1: 105. *tab. 53A*. 1843 (!). Syntypes, *Kotschy 27* & *Aucher 4100* (BM, E, G, K, W). Lectotype, *Kotschy 27* (P, non vidi); isolectotypes (BM, E, G, GH, K, OXF, W).

Alyssum pleiospermum Fenzl, Ill. & Desc. Pl. Nov. Syr. & Taur. Occid. 54. 1843 (!). Holotype, *Kotschy 27* (W), isotypes (BM, E, G, GH, K, OXF).

Alyssum meniocoides var. *aureum* (Fenzl) Zohary, Pal. Jour. Bot. Jer. Ser. **2**(2/3): 162. 1941 (!).

Annual, with stout stems, (3–)5–20 cm. tall. *Leaves* (8.5–)12–30 mm. long, and always flat. *Petals* golden, spathulate, retuse or bilobed, 4–6.5 mm. long. *Long filaments* 2–4 mm. long, wing terminated with lanceolate or bifid apex, 0.5–1 mm. long. *Short filaments* 2–3 mm. long with lanceolate or bifid appendages 1–1.5 mm. long. *Fruits* glabrous. *Styles* 1–1.8 mm. long. *Seed wing* 0.2–0.4 mm. wide. *Fl.* Mar.–June.

DISTRIBUTION AND HABITAT: dry cultivated lands, steppe and marly vineyards in Lycaonia, the Upper Euphrates region and Mesopotamia of Turkey, the Syrian desert of Western Syria and Palestine; alt. 400–2500 m.

Turkey. B6: Prov. Malatya, Derinje (Darende), 18 Apr. 1917, *McDaniels* (CU). B7: Prov. Erzincan, Sürek, 1890, *Sintenis 130b* (G); Prov. Elâziğ, Elâziğ-Kale, 22 km. E. of Elâziğ, 1300 m., *Davis 28938* (BM, E, K); Harput, *Noë 857* (G); Prov. Malatya, Malatya, 1000–2500 m., *Ajtaikovitch* (W); Arapkir-Denizli, 1889, *Sintenis 153* (E, W). C4: Prov. Konya, Ayos Philibos (Hagios Philippos), nr. Konya, *Post B16* (G); Çumra dist., Kücük köy, *Helbaek 2400* (E). C6: Prov. Gaziantep, Yonas, 25 km. E. of Gaziantep, 914 m., *Haradjian 1770b* (G). C7: Prov. Urfa, Djebel Taktak (Tektek dağ), Apr. 1867, *Haussknecht, p.p.* (BM). **Syria.** Turmainen nr. Aleppo, 396 m., 12 Mar. 1865, *Haussknecht, p.p.* with *A. meniocoides* (G, W); Aleppo, *Haussknecht 98* (G); Yab Sam, 400 m., *Dinsmore 20409* (G, K); Kalat, *Rogers 599b* (K); Djebel Muhassan, 12 Mar. 1863, *Haussknecht* (G); El Jebath-El Beithata, 11 Apr. 1890, *Post, p.p.* with *A. meniocoides* (BM); Haurân, *Post s.n.* (BM). **Palestine.** Amman-Ziza, *Eig & Zohary 1929* (HUJ); Amman-Abu Jaber, 1000 m., *Samuelsson 2838* (W). **Iraq.** nr. Mosul of Kirkuk, *Guest s.n.* (K); Baghdad nr. Kamaracha, 1822, *Olivier*

(G); Hieropolis, Mar. 1867, *Haussknecht, p.p.* with *A. meniocoides* (G, K, W); ibid., 1782, *Michaux* (G).

The species *Meniocus pleiospermum* and *M. grandiflorus* are based on the same type material (*Kotschy 27*) as *M. aureus*, the basionym of *Alyssum aureum*. The other syntype of *M. grandiflorus* (*Aucher 4100*) is correctly referred to *Alyssum linifolium* var. *teheranicum*.

Zohary (Pal. Jour. Bot. Jer. Ser. 2(2/3): 162. 1941) considered that the differences between *A. aureum* and *A. meniocoides* were very slight, and recombined *A. aureum* as a variety of the latter species. *A. aureum* may be distinguished from *A. meniocoides* by its considerably longer styles, larger and retuse or bilobed petals, larger fruit, and usually flat and wider leaves. Although the distinction in petal size and leaf form occasionally breaks down (cf. note under *A. meniocoides*), the much longer styles, and the always retuse or bilobed petals remain diagnostic for *A. aureum*. Furthermore, these species retain their identity in regions of overlap, and they clearly have different flowering times.

The inclusion of *A. aureum* by Parsa (Fl. Iran 1: 747. *fig. 622*. 1952) is probably an error. With the exception of this reference, *A. aureum* has not been recorded from Iran, and no Iranian specimens have been seen at Kew, upon whose collections Parsa based his work. These materials, and Parsa's illustration lead me to conclude that *A. aureum* sensu Parsa is, in fact, *A. minutum*.

4. **Alyssum huetii** Boiss. Fl. Or. 1: 287. 1867 (!). Syntypes, Turkey, 11 May 1869, *Bourgeau*; *Balansa 1252*, *Kotschy 206*, and June–4 July 1853, *Huet*. Lectotype, Turkey, B8: Prov. Erzurum, in neglectis circa Erzurum, 1829 m., June–4 July 1853, *Huet* (G); isolectotypes (BM, K, OXF).

PL. II, FIGS. i, s. PL. III, FIG. a. PL. IV, FIG. b. TEXT-FIG. 1.

Meniocus hirsutus Boiss. & Bal. in Boiss. Diagn. 3(5): 32. 1856 (!), non *Alyssum hirsutum* Bieb. Holotype, Turkey, B2: Prov. Uşak Ouchak (Uşak), 910–940 m., 21 May 1857, *Balansa 1252* (G); isotypes (BM, GH, K, OXF, W).

Annual, with ascending or erect stems up to 40 m. *Leaves* linear or oblanceolate, (8–)30–40 × (0.5–)2–3 mm., ± conduplicate, acute, increasing in size upward. *Racemes* simple, or rarely branched, (5–)10–20 cm. long. *Pedicels* spreading to horizontal, 4–6 mm. long. *Sepals* early deciduous, 1.7–2 mm. long, acute. *Petals* obovate-clavate, shallowly bilobed, (2–)3–4 × 1 mm. *Long filaments* 2–2.5 mm. long, with unilateral wings and teeth (teeth 0.5 mm. long), never exceeding anthers. *Short filaments* 1.2–1.5 mm. long with connate, lanceolate and acute, or bifid appendages, as long or longer than filaments. *Fruits* elliptic or orbicular, obtuse or truncate, 4.5–6.5 × 3–3.5 mm., papillose with ± sparse, slender

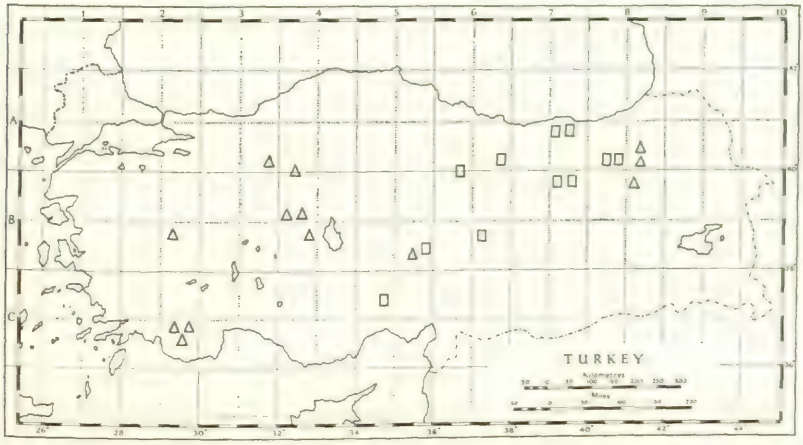
and simple tuberculate setae (0.3–0.5 mm. long); locules 4–6-ovulate. *Styles* stout, 0.5–1 mm. long, ± dilated basally. *Seeds* narrowly winged. *Fl.* May–June.

DISTRIBUTION AND HABITAT: an Anatolian endemic of disturbed sites, cultivated lands and steppe, scattered mainly in Inner Anatolia, from western, southwestern and central Turkey, and extending east to the Armenian Highlands; alt. 800–2500 mm.

Turkey. A3: Prov. Ankara, 10 km. W. of Beypazari, 2 km. W. of Zavije, 1000 m., *Kühne 202* (STU). A8: Prov. Erzurum, Tortum, *Calvert 1240* (G). A/B4: Prov. Ankara, nr. Indize-su, 800–900 m., 1929, *Bornmüller 13853* (BM, GH, K, W). B4: Prov. Ankara, Ankara, *Kotte 1021* (K); Hussein nr. Ankara, *Kotte 121* (K); dist. Haymana, 9 km. W. of Haymana, 1808 m., *Huber-Morath 13723* (HM). B5: Prov. Kayseri, Argaei (Erciyas dağ) nr. Tpshamaki, 1600–2500 m., *Kotschy 206* (G, W). B8: Prov. Erzurum, Erzurum, *Calvert & Zohrab 1240* (E, G, K, OXF, W). C2: Prov. Anatalya, Elmali dağ, 11 May 1869, *Bourgeau* (E, GH, OXF, W); Elmali-Korkuteli, 5 km. from Elmali, 1100–1120 m., *Dudley, D. 35212* (E) & *Dudley, D. 35230* (A, E).

The closest ally to *Alyssum huetii* in Turkey is probably *A. stylare*, which is also an Anatolian endemic. It may be distinguished from *A. stylare* by its shorter and stouter styles, smaller floral parts, and sparser fruit indumentum of shorter and slender setae, and papillae. It is also closely related to *A. heterotrichum* from Iran and Russia.

The fact that the vast area of east-central Anatolia has been little collected probably accounts for the absence of records or specimens of *A. huetii* from that area, which intervenes between the presently known areas of distribution of this species.



TEXT-FIG. 1. Map showing distribution of *Alyssum huetii* (△), and *A. stylare* (□), in Turkey.

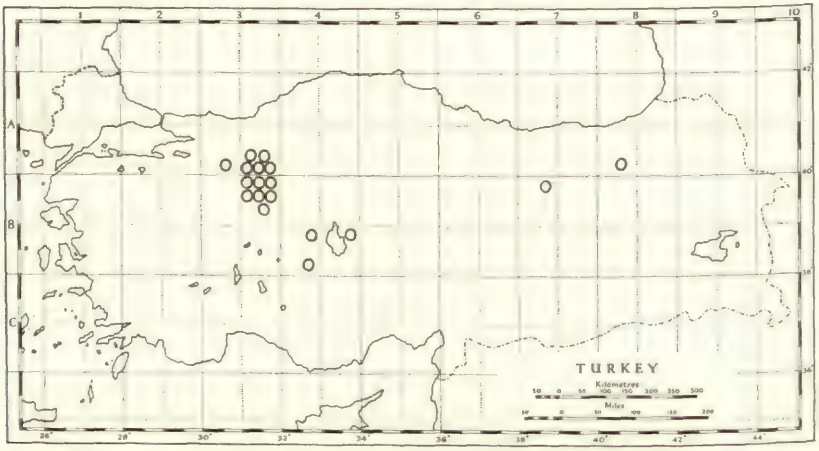
5. **Alyssum stylare** (Boiss. & Bal.) Boiss. Fl. Or. 1: 287. 1867 (!).

Meniocus stylaris Boiss. & Bal. in Boiss. Diagn. 3(6): 16. 1859 (!). Holotype, Turkey, B5: Prov. Kayseri, inter segetes ad basin montis Karamasdagh quinque leucis ad orientem urbis Caesareae siti, c. 1500 m., June & 2 July 1856, *Balansa 486* (G); isotypes (A, K, OXF, W). TEXT-FIG. 1.

Annual, similar to, but larger and coarser than *Alyssum huetii*. *Leaves* (2–)8–20 × 1.8–3 mm., ± conduplicate, obtuse, increasing in size upward. *Inflorescence* lax, multibranched and somewhat circinate, (8–)10–20 cm. long. *Pedicels* spreading to ascending, 5–8 mm. long. Sepals ± persistent, 3–3.5 mm. long. *Petals* deeply bilobed, spathulate and clawed, 4–6 × 2–3 mm. *Long filaments* 3–4 mm. long, with unilateral teeth (0.5–0.7 mm. long) sometimes exceeding anthers. *Short filaments* 1.5–2.5 mm. long, with free (rarely connate) lanceolate appendages, as long or longer than filaments. *Fruits* elliptic to obovate, obtuse, (4–)5–7 × (2.5–)3–4.5 mm., 4–8-ovulate, papillose with very dense, simple or furcate setae (0.5–1 mm. long). *Styles* slender 2–2.5 mm. long. *Seeds* wingless. *Fl.* May–July.

DISTRIBUTION AND HABITAT: a Turkish endemic of central and eastern Anatolia, the Upper Euphrates, the Cilician Taurus and the Anti-Taurus, in neglected fields, high steppe, and often associated with *Quercus-Poterium* scrub; alt. 1300–1850 m.

Turkey. A6: Prov. Sivas, Yaghsian-Tchoudak (nr. Kayulhisar), 1600 m., 1858, *Tchihatcheff* (G). A7: Prov. Gümüşane, Gümüşane, 21 May 1862, *Bourgeau* (G); Molirva-Mesere (nr. Sorda), 1894, *Sintenis 5656* (BM, E, G, GH, K, W). A8: Prov. Gümüşane, dist. Bayburt, Gümüşane-Bayburt, 21 km. from Bayburt, 1620 m., *Huber-Morath 14802* (HM); Bayburt, 11 July 1862, *Bourgeau 171* (G). A/B6: Prov. Sivas Tokat, Sivas-Tokat, N. side of Artova pass,



TEXT-FIG. 2. Map showing distribution of *Alyssum blepharocarpum* (○) in Turkey.

Çamlibel dağ. 1850 m., 14 June 1939, *Reese* (HM). B6: Prov. Maraş, dist. Elbistan, Elbistan-Darende, 28 km. NE. of Elbistan, 1300 m., *Huber-Morath 12821* (HM). B7: Prov. Erzincan, Sipikor dağ (nr. Keşiş dağ), Jerbatan, 1889, *Sintenis 1543* (G, K) & 1890, *Sintenis 3123* (K). C5: Prov. Niğde, Pursuk nr. Ulukisla), 1300 m., 1898, *Siehe 89* (BM, G, K, W).

Among the species of section MENIOCUS, *Alyssum stylare* has the longest styles, and the densest fruit indumentum which is composed of tuberculate, simple (occasionally bi- or trifurcate) setae to 1 mm. long. The furcation of the hairs on the fruit is unique in the section.

Although *Alyssum stylare* is sympatric in the eastern part of its range with *A. blepharocarpum*, it always has larger and obtuse fruits, deeply bifid petals, and wingless seeds. Its larger flowers, denser fruit indumentum, larger and broader leaves, stricter habit, and much longer, circinate inflorescences distinguish it from *A. huetii*.

6. **Alyssum heterotrichum** Boiss. Diagn. 1(6): 15. 1845 (!). — Boiss. Fl. Or. 1: 287. 1867; in Buser, Suppl. Fl. Or., 50. 1888. — Parsa, Fl. Iran 1: 248. *fig. 620*. 1952 — I. V. Pavlov (Ed.), Fl. Kazakhstan 4: 281. *tab. 35, fig. 10*. 1961. Holotype, Iran ad muros hortorum prope ruinas Persepolis, 11 Apr. 1842, *Kotschy 224* (G); isotypes (BM, E, K, OXF, W).

A. bungei Boiss. Fl. Or. 1: 274. 1867 (!). Parsa, Fl. Iran 1: 727. 1952. Holotype, Iran, hab. in Persia, inter Isfahan et Teheran, May 1859, *Bunge* (G); isotype (K).

A. betpakdalense Rubtz. Bull. Mosk. Obshch. Isp. Pri. Biol. 52(2): 87. *fig. 1*. 1947. Holotype, Kasahstania, desertum Betpak-dala centralis in loco Kokaschik, 20 Apr. 1940, *Rubtzov* (AA, non vidi).

Annual, often low and decumbent, rarely more than 10 cm. tall. *Leaves* oblanceolate-spathulate, flat, 7–25 × 1–4 mm., decreasing in size upward. *Inflorescence* dense, 5 cm. or less long, frequently strongly branched with lateral branches ca. ½ as long as terminal. *Pedicels* ascending, 1.5–3 mm. long. *Sepals* ± persistent, obtuse, 1–1.5 mm. long, with very sparse indumentum. *Petals* obovate, emarginate, 0.7–1(–1.5) × 0.5–0.7 mm., greenish yellow. *Long filaments* 1–1.5 mm. long, with unilateral teeth (ca. 0.5 mm. long). *Short filaments* 0.7–1(–1.5) mm. long, with deeply bifid and basally connate appendages, ½ as long as filaments. *Fruits* narrowly elliptic-ovate or obovate, acute or attenuate (rarely otherwise), 3–4.5(–5) × 1.5–3 mm.; densely papillose and with simple, slender, and only slightly tuberculate setae (0.2–0.4 mm. long). *Styles* slender, 0.4–0.7 mm. long, glabrous. *Seeds* wingless. *Fl.* Jan.–Apr.

DISTRIBUTION AND HABITAT: dry rubble and mountain steppe in Iran, Afghanistan and Kazakhstan in Russia; alt. 1200–2000 m.

Iran. Prov. Khorasan, Djenaran-Kucan. *Rechinger 7519, p.p.* (W); Mŏntes Kopet-Dagh, in jugo Alamli, ca. 2000 m., *Rechinger 4760, p.p.* (W); Montes Hazar Masdjid, Ardak-Tolgor, 1200–1600 m., *Rechinger 5047* (W); Prov.

Hamadan, Aq Bulaq, 35° 36′ N., 48° 27′ E., ca. 100 km. N. of Hamadan, *Rioux & Golvan 211* (W); Niriz, Fars, *Koelz 14728* (W); Shiras, 1425 m., *Pravitz 507* (S); nr. Schiraz, Dilguscha, Mar. 1868, *Haussknecht* (BM, G, K, W). **Afghanistan.** Prov. Pawan, 22 km. above Gulbahar in Panjshi valley, 1700 m., *Hedge & Wendelbo 3005* (E).

The type specimens of *Alyssum bungei* do not deviate in any characters from material of *A. heterotrichum*, and accordingly the name, *A. bungei*, should be treated as a synonym of *A. heterotrichum*. Boissier considered *A. bungei* to be the only annual species of section ODONTARRHENA, but he commented that this was an artificial placement based entirely on his observation of its uniovulate fruit locules. I have examined fruits from the type material of *A. bungei* and have found that the fruit locules consistently contain four or five ovules. It is true, however, that only one of these ovules develops into a mature seed, while the others abort. In this case, the fruits are one-seeded and the aborted ovules are visible under magnification. *A. heterotrichum* is the only species in section MENIOCUS having setae on the fruits, and an entirely extra-Anatolian distribution.

7. **Alyssum blepharocarpum** Dudley & Huber-Morath, Jour. Arnold Arb. **45**(1): 61. *pl. I, figs. 1–13.* 1964 (!). PL. I. TEXT-FIG. 2. Holotype, Turkey, B4: Prov. Ankara, dist. Kadinhan, Sarayönü-Cihanbeyli, Weizenfeld, 13 km. nordöstlich Sarayönü, 870 m., 1 June 1956, *Huber-Morath 13722* (HM); isotype (E).

Annual, resembling *Alyssum huetii*, but of more delicate habit. *Leaves* linear, rarely subspathulate, (3.5–)8–20(–25) × 0.5–2 mm., usually decreasing in size upward. *Sepals* (1.5–)2.5–3 mm. long. *Petals* 2–4 mm. long, retuse. *Long filaments* (1.5–)2–3.5 mm. long, bilaterally winged, the wider wings having acute or denticulate teeth (0.5 mm. long), never exceeding the anthers. *Short filaments* 1.5–2 mm. long with connate, lanceolate or denticulate appendages, ½ or more the length of filaments. *Fruits* ovate-orbicular, usually truncate, 3.5–4.5(–5) × 2–3(–3.8) mm., papillose, or smooth, and always with sparse, short, slender tuberculate setae, at least on margins. *Styles* slender, (0.7–)1–2 mm. long. Seeds winged. *Fl.* Apr.–July.

DISTRIBUTION AND HABITAT: an endemic scattered in Inner Anatolia on disturbed lands, cultivated fields, saline steppe, and gypsum outcrops; alt. 500–1620 m.

The specimens known to date, and a discussion of this species may be found in Jour. Arnold Arb. **45**(1): 61–63. 1964.

II. Section PSILONEMA (Meyer) Hooker

KEY TO ALL SPECIES OF SECTION PSILONEMA

A. Fruits orbicular, rotund, oblate or ovate, emarginate or obtuse, with indumentum and smooth margins; sepals persistent; leaf margins entire.

B. Fruit indumentum monomorphic, of stellate hairs only; petals glabrous or rarely with sparse adpressed indumentum; nectaries erect or subulate (up to 2 mm. long), or if ± globose, then fruits obtuse.
C. Fruit indumentum of non-overlapping, short-rayed stellate hairs; styles glabrous; petals retuse; nectaries subulate and erect; fruits emarginate. ..... 8. *A. alyssoides*.
C. Fruit indumentum of long-rayed and overlapping stellate hairs; styles with basal indumentum; petals deeply bifid; nectaries short, ± globose; fruits obtuse. ..... 9. *A. damascenum*.
B. Fruit indumentum strigose and dimorphic, of adpressed stellate hairs, and erect, furcate ± tuberculate hairs; petals with dense strigose indumentum; nectaries always reduced and globose, less than 0.4 mm. long.
D. Seeds winged; styles 0.5–1 mm. long, not basally dilated, glabrous, or with sparse basal indumentum of adpressed stellate hairs; leaves linear-oblanceolate, or elliptic-oblong, increasing in size upwards. ..... 10. *A. granatense*.
D. Seeds wingless; styles (1–)1.5–2 mm. long, strongly dilated at the base with dense dimorphic indumentum; leaves obovate-spathulate, decreasing in size upwards. ..... 11. *A. dasycarpum*.
A. Fruits broadly obovate, truncate, glabrous, with papillose margins; sepals deciduous; leaves minutely denticulate at apices. ..... 12. *A. homalocarpum*.

8. **Alyssum alyssoides** (L.)L. Amoen. Acad. **4**: 487. 1759 (!); Syst. Nat. ed. 10. **2**: 1130. 1759. — Hal. Consp. Fl. Graec. **1**: 99. 1909. — Schinz & Thell. Bull. Herb. Boiss. II. **7**: 407. 1907. — Beck, Fl. Bosne, Herceg. **2**(7): 302. 1916. — Rydberg, Fl. Rocky Mt. & Adj. Plains, 347. 1923. — Hayek, Prodr. Fl. Penin. Balc. **1**: 439. 1925. — Nyár. Magyar Bot. Lap. **24**: *tab. 1, fig. 24*. 1925; Bull. Bot. Grad. Cluj **7**: *tab. 8, fig. 106*. 1927. — Jávorka & Csapody, Ic. Fl. Hung. **7**: 211. *fig. 1590*. 1930. — Degen, Fl. Veleb. **2**: 187. 1937. — Mansfeld, Repert. Sp. Nov. **46**: 114. 1939. — Rech. Fl. Aegaea 225. 1943. — Abrams, Ill. Fl. Pacific States **2**: 319. *fig. 2149*. 1944. — Hylander, Uppsala Univ. Årsskr. **7**: 182. 1945. — Fernald, Gray's Manual of Botany, ed. 8. 699. *fig. 1805*. 1950. — Gleason, New Britton & Brown Ill. Fl. Ne. U. S. & Adj. Canada **2**: 220. 1952. — Lid, Norsk. Fl. 325. 1952. — Parsa, Fl. Iran **1**: 744. *fig. 617*. 1952. — Pawł. Fl. Tatrorum 325. 1956. — Lagerberg, Vilda Växter Nord. **2**: 762. *fig. 394b*. 1957. — Markgraf in Hegi, Ill. Fl. Mitt.-Europa, ed. 2. **4**(1): 288. *tab. 125, figs. 23, 44; tab. 127, figs. 3a, b; fig. 170a*. 1960. — Heywood, Repert. Sp. Nov. **64**(1): 53. 1961. — Dudley, Jour. Arnold Arb. **45**(1): 63–65. 1964; in Rech. Fl. Lowland Iraq 306. 1964. — Ball & Dudley in Flora Europaea **1**: 299. 1964.

Annual or *biennial*, with few or many, erect, decumbent or ascending, rarely prostrate stems, up to 50 cm. long. *Indumentum* grayish-green (rarely silvery) of adpressed stellate hairs having few and ± short rays (density variable). *Leaves* obovate or linear-oblanceolate, up to 4 cm. long. *Racemes* elongated, rarely reduced, up to 15 cm. long, and if

branched, branches never exceeding the terminal axis. *Pedicels* 2–6 mm. long, spreading or horizontal. *Sepals* (1.5–)2–3 mm. long, persistent. *Petals* obovate, usually glabrous, emarginate, 2–3(–4) mm. long, often scarcely exceeding the sepals and persistent with them. *Filaments* 1–1.5 mm. long, always edentate and unappendaged. *Nectaries* slender and erect, 0.5–0.8 mm. long. *Fruits* orbicular, emarginate or truncate, (2–)3–4(–5) mm. long and wide; valves equally inflated at centers, and with flattened margins, covered with an indumentum of minute (0.2–0.3 mm. in diameter) adpressed stellate hairs (density variable). *Styles* 0.3–0.6(–1) mm. long, ± slender, usually glabrous. *Seeds* narrowly winged. $2n = 32$. *Fl.* Mar.–Aug. Two varieties are recognized:

A. Leaves oblanceolate or linear, (3–)10–40 × 1.5–3 mm., with sparse grayish-green indumentum; plants always more than 5 cm. tall, usually 15–35 cm.; racemes elongated, never umbellate, (2–)5–15 cm. long, 10-fruited, or more. ..... a. Var. *alyssoides.*

A. Leaves obovate, 2–3.5 × 0.5–1 mm., with dense silvery indumentum; plants very reduced, 1–3 cm. tall; racemes very reduced and umbellate, 0.5–1 cm. long, 3–7-fruited. ..... b. Var. *depressum.*

a. Var. alyssoides.

Clypeola alyssoides L. Sp. Pl. **2**: 652. 1753 (!). Type, Europe in Austria et Gallia; "2. *Clypeola* siliculis bilocularibus tetraspermis" (BM, hort. Clifford; *Clypeola* No. 2, sub "Alysson incanum luteum serpilli folia.").

Clypeola campestris L. op. cit. 652, 1231. Type protologue refers to Sauvages, *Methodus Foliorum Monspeliensis*. . . . 71. 1751, reading: "No. 405 Clyp. annua siliculis bilocularibus dispermis calyce persistente. . . .", and to C. Bauhin, *Pinax*, 107. 1623, reading: "Alysson dictum campestre minus."

Alyssum calycinum L. Sp. Pl. ed. 2. **2**: 908. 1763 (!). — Jacquin, Fl. Austr. **4**: *tab. 338*. 1776. — Reich. Ic. Fl. Germ. & Helv. **2**: *tab. 18, fig. 4269*. 1837–1838. — Bertoloni, Fl. Ital. **6**: 483. 1844. — Boiss. Fl. Or. **1**: 285. 1867. — Cusin & Ansb. Herb. Fl. Fr. **2**: *tab. 312*. 1869. — Ruprecht, Fl. Caucasi. 105. 1869. — Ettings. & Pokorny, Physio. Pl. Aust. **9**: *tab. 871*. 1873. — Mora, Fl. Fan. Esp. & Port. **6**: 560. 1873. — Willk. & Lange, Prodr. Fl. Hisp. **3**: 833. 1880. — Brandza, Fl. Rom. 136. 1833. — Schlecht., Lang. & Schenk, Fl. Deutschl. ed. 5. **14**: 195. *tab. 1387*. 1883. — Colmeiro, Pl. Penin. Hispano-Lusit. 155. 1885. — Simonkai, Enum. Fl. Transsil. 91. 1886. — Beck, Fl. Nieder-Österr. 469. 1892. — Rouy & Fouc. Fl. Fr. **2**: 185. 1895. (incl. vars.). — Robinson in Gray, Synopt. Fl. N. Am. **1**(1): 115. 1895. — Grecescu, Consp. Fl. Român. 68. 1898 (excl. var. [β] *depressum*). — Pauletti in Fiori & Pauletti, Fl. Anal. Ital. **1**: 457. *fig. 1447*. 1898–1899. — Busch in Kuznetsov, Busch & Fomin, Fl. Cauc. Crit. **3**(4): 601. 1909 (incl. forma); in Fl. U. R. S. S. **8**: 358. 1939. — Bornm. Bot. Centralb. Beih. **38**: 479. 1921. — Szafera, Fl. Polska **3**: 177. 1927. — Boul. Fl. Liban & Syr. *32*. 1930. — Thiébaut, Fl. Lib.-Syr. **1**: 71. 1936. — Palhinha, Fl. Port. ed. 2. 307. 1939. — Grossheim, Fl. Kavk. ed. 2. **4**: 220. *tab. 25, fig. 6*. 1950. — Jessen, Vilde Pl. Nord. **2**: 598. *fig. 410, fig. 411b*. 1950. — Karjagin, Fl. Azerbaid. **4**: 277. 1953. Type, Europe, Austria, Gallia, Germania (BM, hort. Clifford; *Clypeola* No. 2).

Alyssum campestre L. op. cit. 909., pro parte (!).

Adyseton calycinum (L.). Scop. Fl. Carn. ed. 2. **2**: 13. 1772 (!). — Bubani. Fl. Pyrenaea **3**: 209. 1901.

Psilonema calycinum (L.) Meyer. Bull. Acad. Sci. St. Pétersb. **7**: 132. 1840 (!); Mém. Acad. Sci. St. Pétersb. VI. **6**: 15. *tab. 2, upper right*. 1840; in Ledebour. Fl. Ross. **1**: 137. 1842. — Schur. Enum. Pl. Transsil. 630. 1866 (excl. var. *depressum*). — Fedtschenko. Fl. Ross. Austro-Orient. **5**: 440. *pl. 388, fig. A*. 1931. — Popov. Fl. Ukraine **5**: 344. 1953.

Alyssum ruderale Jordan. Diagn. Nouv. 198. 1864. Type. Switzerland. hab. in ruderatis et agris incultis circa Genève. *Jordan* (P, non vidi).

A. vagum Jordan, *ibid.* Type. France. hab. in ruderatis et sabulosis agris lugdunensis. Villeurbanne (Rhône). *Jordan* (P, non vidi).

A. sabulosum Jordan, *op. cit.* 199. Type. France. hab. in sabulosis Beugesi. Thoirette (Ain). *Navier* (P, non vidi).

A. arvaticum Jordan, *op. cit.* 200. Type. France. hab. in ruderatis et arvis. Delphinatûs superioris; La Grave (Hautes-Alps). *Jordan* (P, non vidi).

A. erraticum Jordan, *loc. cit.* Type. France. hab. in ruderatis et arvis pyrenaeorum Gèdre (Hautes-Pyrénées). *Jordan* (P, non vidi).

A. sublineare Jordan, *op. cit.* 201. Type. France. hab. in ruderatis et sabulosis montium Occitanieae. Mas-Cabardès (Aude). *Jordan* (P, non vidi).

DISTRIBUTION AND HABITAT: a widespread weed species of western, central and southern Europe, Russia, North Africa and Afghanistan in ruderal and disturbed habitats and mountain meadows; sea level–2000 (–2800) m. Probably introduced and naturalized in northern Europe, including the British Isles and Scandinavia. Naturalized in the United States and Canada, and in the Argentine of South America. Recorded from Turkey.

England. Dirleton Common, 24 June 1835. *Macnab* (E); Surrey. Wandsworth, July 1835. *Hunter* (E). **France.** Montpellier. Herault. 27 Apr. 1894. *Galavielle* (E, G, W); ibid., *Arnott* (E, K); Paris. *Forbes s.n.* (E); Zabern, May 1896. *Krebs* (BM, E, G, K, W); Loches. Apr. 1841. *Trevelyan* (E, K); Paris. Bois de Boulogne. *Cosson* (G, GH); La Maures. Hyères. 30 Apr. 1906. *Raine* (GH). **Corsica.** Mt. Pietro. *Solenol 355* (BM). **Spain.** Pyrenees. 2 May 1896. *Guillot* (BM); Centellas. Pyrenees, nr. French border. *Lesins 24* (A); Sierra del Cuarto. 1800 m., *Reverchon 1276* (BM, E, G); Barcelona. *Gonzala 5453* (BM); ibid., 450 m., *Gonzala 5434* (BM); ibid., 3 May 1918. *Sennen* (BM, E); ibid., Cantalejo. *Sennen 2964* (BM); Cerdagne, 1380 m., 12 June 1926. *Sennen* (BM); ibid., Angoustrone Grande Rigole. *Sennen 6040* (BM); Sierra de Barza. 1890. *Ball* (BM, E, GH, K); Distr. Logrono Sorio. Viniegra-Montenegro. Sierra de la Urbion. 1700 m., *Dresser 610* (E). **Sweden.** Skåne i Alnarp. June 1841. *Palmer* (E); Uppsala. *Anderssen s.n.* (E); ibid., July 1866. *Ahlberg* (GH, K); Askersund. 11 June 1887. *Wyring* (BM, GH, K); Prov. Gotland. Paroecia Alskog. *Asplund 877* (BM, GH, W); Stenkyrka. 19 June 1867. *Oldberg* (GH). **Denmark.** Isle of Möen. June 1926. *Jöker* (GH, W); ibid., May 1846. *Tütein* (GH); ibid., *Schonid* (GH). **Germany.** Jura, nr. Regensburg. 410 m., *Rubner 781a* (BM, E, K, W); Munich. May–June 1829. *Rosh* (E, W); Thusran. *Grierson 30* (E); Baden nr. Wiesloch. 200 m., *Zimmerman 8* (BM, E, K, W); Berlin. 14 May 1896. *Rehder* (GH); Kies. 800 m., *Zick 781a, b* (BM, G, GH, K, W); Thuringia, nr. Arustadt. 19 Apr. 1902. *Reineck* (GH, W). **Switzerland.** Zurich. 26 June 1880. *Rehder* (GH); May 1836, *Naegeli* (E, W); Thun. Apr. 1838. *Brown* (E, K); Vallaris Rhône. May 1858, *Balfour* (E); Aug. 1889. *Dickson* (E); Aigle. 4–9 June 1885.

Hamilton (E); Jura, nr. Neuville, 9 Aug. 1834, *Shuttleworth* (E); Zermatt-Zmutt, May 1961, *Dudley* (A); Chur, 700 m., *Meisser 340* (BM, G, GH, K, W); *Seringe 2891* (BM, GH, K). **Italy.** Sulmona, Campio de Jaeve, *Lesins 11* (A); Naples, 1845, *Alexander* (E); nr. Bormio, 18 Aug. 1870, *Ball* (BM, E, K); Florence, *Babington* (E); St. Cauzian, *Crawford 26* (E); Calabria, Sila nr. San Giovanni in Fiore, 1000 m., 1933, *Bornmüller 80* (A). Sicily, Mt. Nebrodense, *Todaro s.n.* (G, GH, W); 1700–1934 m., 21 July 1874, *Stroblysi* (BM). **Poland.** Kielce, 18 May–30 May 1897, *Bodzentyn* (E, W); Kiovise nr. Karawajewi, *Lazarenko 65* (BM, E, K, W); Prov. Kioviensis, distr. Smila, pr. Jablunilvka, *Kleopow s.n.* (BM, E, K, W). **Czechoslovakia.** Kaaden, nr. Tältsch, 700 m., *Stelzhamer 346* (BM, E, G, GH, K, W). **Austria.** St. Veit, 6 June 1898, *Krebs* (E, G, K, W); nr. Graz, 360 m., *Kritsch 749* (BM, E, G, K, W); nr. Judenburg, 710 m., *Pilhatsch 748* (BM, E, G, K, W); Mariazell, *Fleischmann s.n.* (BM, E, G, GH, K, W); Laibach, *Fleischmann s.n.* (BM, E, G, GH, K, W). **Hungary.** Mt. Rokahety nr. Bekras, 4 June 1922, *Degen* (W); Sórkut-Torik-Bálirit, 24 June 1922, *Degen* (W); Chemnitz, 1890, *Ball* (BM, E, GH, K). **Romania.** Transsilvania, distr. Brasov, nr. Härman, 500 m., *Borza 651c* (BM, E, G, K, W); distr., Turda Aries, Cheia Turzii, nr. Turda, 450 m., *Borza 651a* (BM, E, G, K, W); distr. Constanta, Dobrogea, nr. Murfatlar, 100 m., *Borza 651b* (BM, E, G, K, W). **Yugoslavia.** Macedonia, Crni Drin, Struga-Debar, *Rechinger 15975* (W); Serbia orientalis, Bela Palanka-Pirot, 600–800 m., *Rechinger 15865* (W); ibid. Nischka Banja, nr. Nisch, *Rechinger 16072* (W); ibid., Nischa Banja-Bela Palank, 600–800 m., *Rechinger 15839* (W); Serbia, Vanjano, May 1898, *Adamovic* (E, W); Sarlark nr. Pirot, 15 May 1897, *Adamovic* (E, K, W). **Albania.** Bertiscus, nr. Pec (Ipek), 500–700 m., *Rechinger & Scheffer 104* (W); Katimi nr. Bukovik, distr. Hati, *Baldacci 298* (BM); Kolasia, *Baldacci 9* (BM); Kia nr. Skutari, *Dörfler 153* (W). **Greece.** Terkovic-Sliovo, *Rechinger 8* (W); Epirus, Tonschiefer, nr. Arachthos river, *Rechinger 23199* (W); Macedonia orientalis, distr. Drama, Boz dagh, nr. Juricik, 300 m., *Rechinger 6351b* (W); ibid., Lekhani-Kechrokampos, valley of river Mesta (Nestos), 700–900 m., *Rechinger 15632* (W); Thrace, Orestias-Visi, *Rechinger 22031* (W); ibid., Mt. Rhodope, nr. Jasmos (Jasi-Koi), *Rechinger 9579* (W); Mt. Olympus nr. Hagios, Diontsios, 800 m., 21 Mar. 1940, *Charworth-Masters 9579* (BM); Xanthi, *Lesins 6* (A); Mt. Malevo, Laconiae, *Orphanides 2638* (G, W); Parhes, Hagios-Trios, 400 m., *Samuelsson 141* (W). **Crete.** Lassithi, Mt. Lazaro, *Gandoger 77* (BM). **Russia.** Crimea, Yalta, above Nikita, 350 m., *Davis 33328* (BM, E, K); Crimea, 1820, *Steven* (G–DC); Kiev, *Zinger 555* (E, W); Königsburg (East Prussia), *Baenitz s.n.* (BM, E, G, GH, K, W); Caucasus, Prov. Terek, Ossetia Balta, *Brotherus 86* (BM); ibid., 17 July 1911, *Busch* (BM, E, G, GH, K, W); Prov. Chewsuria, 1 Aug. 1903, *Busch* (BM, E, G, GH, K, W); Daghestan, 1874, *Becker* (BM, K); Azerbaidjan, Ismaily, Ovanovka-Ismaily, 24 May 1936, *Grossheim* (BM). **Bulgaria.** Varna, 1846, *Noë* (K); Haskovo-Harmanli, *Rechinger 21770a* (W); nr. Sreden-tschitlik, close to Russian border (Rustschuk), *Rechinger 638* (W); Black Sea, Aladscha, Sveti Konstantin, nr. Varna, *Rechinger 1057* (W); Čerpan, June 1900, *Stribrny p.p.* (E, K, W). **Turkey** (records only). A2(A): Prov. Bursa, Bithynia Olympo (Ulu dağ), *Sestini* (fide Fenzl in Tchihatcheff, Asie Min. Bot. 1(3): 313. 1860). A7: Prov. Trabzon, Boztepe, 21 June 1917, *Schischkin* (fide Schischk. Ber. Staats-Univ. Tomsk **80**: 465. 1929); Prov. Trabzon Gümüşane, nr. Vischera, Kalanema Dere, 500 m., June 1908, *Blumencron* (fide Handel-Mazzetti, Ann. Naturh. Mus. Wien **23**: 156. 1909). B6: Prov. Maraş, Elbistan, *Asdurian 85* (fide Béguinot & Diartz. Contrib. Fl. Arm. 47. 1912). B10: Prov. Doğanbayazit, Dutach-Bur-

nubulak, 26 May 1916, *Schischkin* (fide Schischk. loc. cit.). C6: Prov. Gaziantep, Killis, *Post 335* (fide Post, Bull. Herb. Boiss. II. 3: 163. 1895). Tokat-Erzurum, *Aucher s.n.* (fide Fenzl, loc. cit.). **Afghanistan.** Prov. Kabul, Kabul-Paghman, 2800 m., *Hedge & Wendelbo 3146* (BG, E).

Canada. Quebec. Wolfe County, nr. Lake Aylmer, *Wells 37470* (GH); Missisquoi County, Philipsburg, 10–11 Aug. 1923, *Knowlton* (GH); ibid., *Marie-Victorin & Rolland-Germain 34152, 43296* (GH). Ontario. Waterloo County, German Mills, Cressman's woods, *Montgomery 198* (GH); Learmington, *Macoun 33775* (GH).

United States. Maine. Orono, 16 June 1890, *Fernald* (NEBC); Bar Harbor, 11 June 1899, *Rand* (NEBC). Vermont. Chittenden County, Colchester, S. of Porter's Swamp, *Charette & Smith 2430* (NEBC); ibid., *Charette 2439* (NEBC). Massachusetts. Suffolk County, Franklin Park, Boston, 11 June 1891, *Manning* (GH, NEBC); Jamaica Plain, June 1875, *Faxon* (GH); Medford-Malden, May 1880, *Davenport* (GH); ibid., 6 May 1882, *Manning* (NEBC); Belmont, 6 June 1898, *Hoffmann* (NEBC); Medford, 24 June 1880, *Davenport* (NEBC); Somerville, 10 May 1878, *Perkins* (NEBC); Norfolk County, Milton, 6 June 1897, *Kennedy* (GH); ibid., 17 July 1915, *Kidder* (NEBC); Barnstable County, Bourne, nr. Monument Beach, 20 June 1911, *Knowlton* (GH, NEBC); Falmouth, July 1882, *Farlow* (NEBC); Bristol County, Dartmouth, *Sturtevant s.n.* (NEBC); ibid., 13 June 1904, *Hervey* (NEBC); Amherst, 1859, *Gray* (GH). Rhode Island. Providence, 12 June 1890, *Collins* (NEBC). Connecticut. New Haven County, Lighthouse Point, East Haven, *Eames 216* (GH); ibid., 17 June 1902, *Harger* (NEBC); Middlebury, *Harger 4290* (NEBC); Hartford County, Southington, 31 May 1897, *Bissell* (NEBC). New York. Washington County, Vaughn, N. of Hudson Falls, 10 June 1915, *Burnham* (GH); Tuckahoe, 12 May 1894, *Pollard* (GH); Mt. Beacon, Hudson River, opposite Newburgh, June 1906, *Kochler* (GH); nr. Plattsburgh, *Hunnewell 4667* (GH); Onondaga County, East Green Lake, Jamesville, *Wiegand 15516* (GH); Columbia County, Becraft Mt., Greenfort, *McVaugh 317* (GH). Pennsylvania. Mt. Airy reservoir, 12 May 1871, *Parker* (GH); Berks County, Bernville, *Stoudt & Hermann 2768* (GH); College Hill, Easton, June 1875, *Porter* (GH); ibid., 8 June 1892, *Porter* (GH). West Virginia. Greenbrier County, White Sulphur Springs, *Hunnewell 2593* (GH); Berkeley County, nr. Inwood, *Hunnewell 19182* (GH). Virginia. Clarke County, nr. Boyce, *Allard 106* (GH); ibid., *Hunnewell 14991* (GH); Shenandoah County, Pugh's Run, *Artz 830* (GH); ibid., Strasburg, *Baldwin 5064* (GH); nr. Cedarville, *Pease 26574* (GH). Michigan. Near Lansing, 8 June 1887, *L. H. Bailey* (GH); Berrian Springs, *Pease 17777* (GH). Indiana. Tolleston, *Umbach 1787* (GH); Fulton County, 1 mile Ne. of Leiter's Ford, *Deam 56019* (GH). Wisconsin. County highway "D," S. of Madison, 18 June 1945, *Greene* (GH). Illinois. Ravenswood, nr. Chicago, 7 June 1883, *Arthur* (GH); McHenry County, Algonquin, *Benke 5741* (GH); Kankakee County, E. of St. Anne, *Jones 11430* (GH). Montana. Many Glaciers, Glacier Park, *Pease 22323* (GH); Riverside Park, 975 m., *Kirkwood 1129* (GH). Idaho. College campus, Moscow, *Henderson 2759* (GH); ca. 2 miles S. of Grangeville on Whitebird Road, *Jones 73* (GH); 3 miles E. of Joseph on Joseph-Whitebird Road, *Jones 163* (GH); Teton County, Victor, 1829 m., *Payson & Payson 2160* (GH). Wyoming. Sheridan County, Red Grade, E. slope of Big Horn Mt., 1981 m. *Rollins 57177* (GH). Utah. Newton-Heyde Park, *Jones 288* (GH); Salt Lake City, *Rollins 3095* (GH); Cache County, Sage E. of U. S. A. C. stadium, Logan, 1433 m., *Maguire 34581* (GH). California. Oakland, *Brewer 2577* (GH); Siskiyou County, Yreka, *Smith*

90, 655 (GH); ibid., Sisson, *Heller 8054* (GH); ibid., Parker ranch, Plowman's valley, 12 June 1948, *Parker* (GH). Oregon. Selkirk, nr. Nelson, *Shaw 663* (GH); Des Chutes river, 5 miles below bend, *Peck 1713* (GH).

Argentina. Partido de Saavedra, Sierra de la Ermita, *Cabrera 5459* (GH).

The nomenclatural confusion between *Alyssum alyssoides* and *A. minus* (*A. campestre* sensu multo auct.) has been discussed in an earlier paper (Jour. Arnold Arb. **45**: 63–65. 1964). Although these two species are assigned to different sections, to section PSILONEMA and section ALYSSUM respectively, they are frequently confused. The sepals of *A. alyssoides* are always persistent, its filaments are very slender, edentate and unappendaged, its nectaries are peg-like and erect, and its styles are usually glabrous. In addition, the symmetrically inflated fruits of *A. alyssoides* are generally smaller, and the easily displaced indumentum on the fruits is composed of shorter-rayed stellate hairs.

Although specimens of *A. alyssoides* have been recorded from Turkey, I have not seen any Turkish material. Certainly its presence in Anatolia needs confirmation. It seems safe, however, to assume that the records from the Armenian Highlands in eastern Turkey are correct. It is well known from the Caucasus, and its presence in Armenia would be an expected pattern of distribution. Throughout the Levant, *A. alyssoides* is very rare (cf. Bornmüller, Bot. Centralbl. Beih. **38**: 479. 1921). For the most part, the Caucasian, Turkish and Afghanistan specimens of *A. alyssoides* are from higher altitudes (e.g. *Hedge & Wendelbo 3146*, Afghanistan at 2800 m.) than are those normally found in Europe. From the paucity of records and specimens from the Levant it is assumed that this species has been unable to colonize and spread in the ruderal and disturbed types of environments, with which it is normally associated throughout much of Europe. Rather, it is apparently confined to isolated pockets in the mountains. Conversely, it is interesting to note that it has adapted well to the ruderal habitats of North America, and accordingly seems to be commoner than in Turkey.

As a common European species *A. alyssoides* has long been subjected to a very critical examination by numerous workers, many of whom (i.e. Jordan, Sennen, Nyárády, Prodan, etc.) have contributed to the literature approximately thirty taxonomic segregates, mostly of varietal or formal rank, and almost twice as many recombinations. As it would not be in the interests of brevity or clarity to cite all of those minor synonyms, I have referred only to those species of Jordan which subsequently have been recombined many times as subspecies, varieties, formae, and even subformae. This species is very polymorphic with respect to plant height, stem length, leaf size, leaf, fruit and sepal indumentum density, and raceme length. The many segregates, excluding var. *depressum* which follows, have been based chiefly on single character deviations, which are very flexible and unstable according to the varying environmental pressures. Many of the characters rarely occur on a population basis, and examination of the type specimens has revealed that, more often than not,

the characters are not constant on individual plants. When the morphological variation of *A. alyssoides* is considered throughout the whole range of distribution, characters such as density of fruit indumentum do not appear to have the stability essential for taxonomic recognition. The one exception is var. *depressum* which forms small and scattered, but phenotypically stable populations in Romania, Hungary, Bulgaria, Greece, and Crete.

b. Var. **depressum** (Schur) Dudley, comb. nov.

Psilonema calycinum var. [c.] *depressum* Schur, Enum. Pl. Transsil. 62. 1866 (!). Holotype, Romania, Hermannstadt, *Schur s.n.* (W).

Alyssum calycinum var. *pumilum* Hal. Denkschr. Akad. Wien Math. Naturw. **61**: 496. 1894 (!). Holotype, Greece, Arcadia, in lapidosis calcareis regionis abietinae Mt. Chelmos (Aroania vet.) gregarie., 1500 m. (in der Tannenregion des Chelmos oberhalb Sudena, 1200–1500 m.). 15 Apr. 1893. *Halacsy* (W).

A. calycinum var. [β] *depressum* (Schur) Grecescu, Consp. Fl. Rom. 69. 1898 (!).

A. calycinum var. *minus* Velen. Sitz-ber. Böhm. Ges. Wissen. Prag **27**: 3. 1902 (!). Holotype, Bulgaria, in Mt. Tikiski, Balkan, *Urumov* (PRC, non vidi); isotype (W).

A. conglobulatum Fil. & Jáv. Magyar Bot. Lap. **9**: 146. 1910 (!); Rep. Nat. Mus. Hung. 107. *tab. 1, fig. 2*. 1910. Holotype, Hungary, in virgultis cacuminis montis Nagy-Szénáshegy ad pag. Pilissentwány, Comit. Pest, ca. 500 m., 9 June 1909, *Filarszky & Kümmerle* (BP, non vidi); isotypes (BM, E, G, K, W).

A. alyssoides var. *conglobulatum* (Fil. & Jáv.) Jáv. Fl. Hung. 441. 1924 (!); Jáv. & Csapody, Ic. Fl. Hung. **7**: 211. *fig. 1590a*. 1930.

A. alyssoides var. *pumilum* (Hal.) Hayek, Prodr. Fl. Penin. Balcan. **1**: 439. 1925 (!). — Vierh. & Rech. Öst. Bot. Zeit. **84**: 139. 1935. — Rech. Fl. Aegaea 225. 1943.

A. alyssoides f. *minus* (Velen.) Hayek, loc. cit. (!).

A. calycinum f. *minus* (Velen.) Stoj. & Steff. Fl. Bulg. ed. 2527. 1948 (!).

DISTRIBUTION AND HABITAT: rare on calcareous substrates of mountains in Hungary, Romania, Greece and Crete.

Hungary. Comit. Pest, Mt. Szénáshegy nr. Pilisszentiván, (locus classicus), 400–500 m., *Filarszky & Jávorka 46* (BM, E, G, GH, K, W). **Crete.** Pezzuta, *Todaro s.n.* (W); Mt. Psiloriti, nr. Nidha, *Dörfler 774a* (W).

9. **Alyssum damascenum** Boiss. & Gaill. in Boiss. Diagn. 3(6): 18. 1859 (!). — Boiss. Fl. Or. **1**: 285. 1867. — Bornm. Verh. Zool.-Bot. Ges. Wien **48**: 553. 1898. — Boul. Fl. Lib. & Syr. 32. *pl. 38, fig. 2*. 1930. — Post & Dinsmore, Fl. Syria, Pal. & Sinai, ed. 2. 1:88. 1932. — Thiébaut, Fl. Lib.-Syr. **1**: 71. 1936. — Zohary, Pal. Jour. Bot. Jer. ser. 2(2/3): 129 & 161. 1941. Holotype, Syria, in cultis inter Merre et Damascum (Jardin e Ganchedulu), 18 Mar. 1847, *Gaillardot 817* (G); isotype (A).

Annual, low growing, resembling *Alyssum contemptum* in habit; sparingly branched from the base, 5–10 cm. in height. *Leaves* oblanceolate-spathulate, acute, decreasing in size upward, uppermost involucrate; indumentum on the lower surfaces denser, and of smaller stellate hairs than that on upper surfaces. *Racemes* simple, or sparsely branched from the base, 1–4 cm. long. *Pedicels* erect or ascending, ± basally dilated, 3–5 mm. long. *Sepals* persistent, ca. 2 mm. long, with narrow scarious wings; indumentum sparse, but with apical tufts of furcate, erect hairs. *Petals* narrowly spathulate, 2.5–3 × 0.5–0.8 mm., deeply bifid. *Filaments* 2–3 mm. long, edentate and wingless. *Fruits* ovate or rotund, 3.5–4.5(–5) × 3–4.5 mm., obtuse; valves ± equally inflated, and with ± dense indumentum of relatively coarse stellate hairs. *Styles* 0.6–1 mm., with basal indumentum. *Seeds* narrowly winged. *Fl.* Mar.–Apr.

DISTRIBUTION AND HABITAT: a Saharo-Sindian species of dry hillsides and cultivated or fallow fields in Syria and Palestine; alt. 200–1000(–1900) m.

Syria. Aleppo-Aintab (Gaziantep), 610 m., 6 May 1865, *Haussknecht* (BM, G); Mt. Carmel, Apr. 1928, *Druce* (OXF); Damascus, Salatie, *Péronin 583 p.p.* (G); ibid., Kessoue, *Péronin 1879* (G); ibid., *Davis 5633* (E, K); ibid. Mt. Gebel Khaisoun, *Gaillardot 856* (G). **Palestine.** Jericho, Ain-i-Sultan-Wadi Kilt, 200 m., 1897, *Bornmüller 71* (G, W). **Lebanon.** Dschebel Sannin, 1700–1900 m., 10 June 1904, *Kneucker* (GH).

Alyssum damascenum is sometimes confused with *A. minus*, a weedy species in section ALYSSUM common throughout most of Europe and the Near East, because of a resemblance in fruit shape and indumentum. The filaments of *A. damascenum*, however, are always wingless, edentate, and unappendaged, while those of *A. minus* are widely winged, appendaged, and usually dentate. *A. contemptum* from Palestine, another species of section ALYSSUM is sometimes confused with *A. damascenum* due to the annual, low growing habit. *A. contemptum* has widely winged toothed and appendaged filaments, small globose nectaries, entire or merely emarginate petals, and elliptic fruits whose valves are very asymmetrically inflated, similar to those of *A. szowitsianum*. The fruits of *A. damascenum* are orbicular with more or less equally inflated valves, its nectaries are erect and peg-like, and its petals are deeply bifid.

Zohary and Fahn (Pal. Jour. Bot. Jer. ser. 2(2/3): 130. 1941) and Zohary (op. cit. 161) assign *A. damascenum* to the group of annual species in section ALYSSUM (including *A. marginatum* and *A. szowitsianum*) characterized by a unique pedicel anatomy associated with the specialized hygrochastic method of seed dispersal. However, in addition to possessing the diagnostic features of section PSILONEMA, *A. damascenum* has a pedicel anatomy, which (as originally noticed by Zohary & Fahn) is different from that of the other species mentioned. These facts suggest that, although the annual species of section PSILONEMA and section

Alyssum are closely allied, the phenomenon of hygrochastic dispersal has developed convergently within the two sections.

10. **Alyssum granatense** Boiss. & Reut. Pug. Pl. Nov. Afr. Bor. & Hisp. Aust. 9. 1852 (!). — Mora, Fl. Fan. Esp. & Portug. 6: 561. 1873. — Willk. & Lange, Prodr. Fl. Hisp. 3: 833. 1880. — Cosson, Ill. Fl. Atl. 1: 61. *tab. 42*. 1884; Comp. Fl. Atl. 2: 236. 1887. — Batt. in Batt. & Trab., Fl. Algérie 1: 47. 1888. — Cadevall & Sallent, Fl. Catal. 1: 142. 1915. — Palhinda, Fl. Portug. ed. 2. 307. 1939. — Heywood, Repert. Sp. Nov. 64(1): 53. 1961. — Quezel & Santa, Nouv. Fl. Algér. 1: 410. 1962. — Ball & Dudley in Flora Europaea 1: 299. 1964. Syntypes, Spain, in arenosis et cultis regionis alpinae montium Granatensium, Sierra de la Nieve supra Yunquera, *Boissier & Reuter* (BM, G, W); in Sierra Nevada circa Benalcaza, *Boissier* (BM, G, W). Lectotype, Sierra de la Nieva supra Yunquera, *Boissier & Reuter* (G); isolectotypes (BM, W).

A. willkommii de Roem. ex Willk. Linnaea 25: 8. 1852 (!). Holotype, Spain, in collibus arenosis siccis prope oppidum Ayamonte, Jan. 1846, *de Roemer* (LZ, destroyed); isotype (BM).

A. granatense var. *sepalinum* Pomel, Nouv. Mat. Fl. Atl. 231. 1874 (!). Holotype, North Africa, a Garrouban, Téniet-el-Haâd, Tala-Yezid, *Pomel* (AL, non vidi); isotype (W).

A. algeriense Pomel, op. cit., 232 (!). Holotype, North Africa, de Garrouban à Téniet-el-Haâd, *Pomel* (AL, non vidi); isotype (W).

A. algeriense var. *montanum* Pomel, loc. cit. (!). Holotype, North Africa, Djebel Endatte, près de Téniet-el-Haâd, *Pomel* (AL, non vidi); isotype (W).

A. hispidum Loscos & Pardo ex Willk. Ill. Fl. Hisp. & Balear. 1: 85. 1882 (!); Suppl. Prodr. Fl. Hisp. 304. 1893. — Syntypes, Spain, en Castelserás particul. en el Cerillo de Calvario, en la huerta de Torrecilla, Castellote, Calaceite y nesesar, pasá á Cataluña par Caseras, *Loscos* (W); cerca de Aranda, *Calavia* (W). Lectotype, Aragon, Castelserás, 25 Jan. 1846, *Loscos* (W); isolectotype (G).

A. hispidum var. *granatense* (Boiss. & Reut.) Willk. Ill. Fl. Hisp. & Balear. 1: 85, 86. 1882 (!); Suppl. Prodr. Fl. Hisp. 304. 1893.

A. marisii Cout. Bol. Soc. Brot. 25: 189. 1910. Holotype, Portugal, hab. in Beira meridional (Castello Branco) Malpica Baixo Alemtejo (Beja), *Maris s.n.* (COI, non vidi).

A. hieronymii Sennen, Bol. Soc. Arag. 15: 259. 1919 (!). Holotype, Spain, Castillo, Madrid, 15 Apr. 1915, *Jerónimo 2411* (BC, non vidi); isotype (BM, W).

A. granatense var. *weilleri* Emb. & Maire, Bull. Soc. Hist. Nat. Afr. Nord. 23: 164. 1932. Syntypes, North Africa, hab. in rupestribus cristallinis editis Anti-Atlantis ad Agadir-n-Tigfert, 1700–1800 m., 1931, *Weiller* (AL, non vidi); in Monte Fidoust, 2000–2200 m., 1931, *Weiller* (AL, non vidi).

Annual, with numerous erect or decumbent stems, up to 20 cm. long. *Leaves* linear-oblanceolate, lanceolate, or elliptic and oblong, 3–20(–25) × 1–3 mm., increasing in size upward, indumentum grayish-green, of adpressed stellate hairs. *Fruiting racemes* generally simple, elongated, 2–8 cm. long, densely fruited. *Pedicels* 2–4 mm. long, ascending to erect,

and adpressed to the main axis, indumentum dense and ± strigose. *Sepals* persistent, 2–3.5 mm. long, with wide scarious wings, and often with apical tufts of furcate hairs. *Petals* clavate, gradually attenuate into claws (3)–4(–6) mm. long, emarginate, with dense strigose indumentum. *Filaments* very slender, edentate and unappendaged, 2–2.5 mm. long. *Fruits* orbicular, 3–5 mm. long and wide, emarginate; valves equally inflated at centers and with wide flattened margins, indumentum dimorphic of tuberculate, simple and furcate hairs, intermixed with adpressed few-rayed stellate hairs. *Styles* 0.5–1 mm. long, glabrous or with sparse basal indumentum. *Seeds* conspicuously winged. *Fl.* Feb.–Apr.

DISTRIBUTION AND HABITAT: cultivated and fallow lands, and dry mountain screes in eastern and southern Spain, Portugal, and North Africa! alt. 600–2200 m.

Portugal. *Sampaio 2471* (BM). **Spain.** Aragonia, *Boissier s.n.* (G, W); Murcie, Sierra de Espuña, 1200–1400 m., *Jerónimo 7101, 6715* (BM); Almeria, N. slopes of Sierra de Maria above Maria, *Ellman & Sandwith* (BM, GH, K); Pozuelo nr. Madrid, *Bucknell* (BM, E); ibid., New Castile, 11 Apr. 1907, *White* (E); Prov. Valencia, Sierra de Espadán, 1800 m., *Reverchon 21* (BM, E, G, K, W); Le Pozo, 1500 m., *Reverchon 706* (W); Sierra de Alcaraz, 600–1000 m., 1890, *Porta & Rigo* (BM, G, W). **North Africa.** Maroc, Djebel Lalla Aziza, Ibrahim, 1883, *Cosson* (BM, E, G, K, W); Djebel Kerher, 850 m., *Sennen & Mauricio 9237* (BM); Batna, 14 Mar. 1867, *Dukerley* (BM, GH, K); Nogen Atlas, Ain Kahta, 1850 m., *Jahandiez 322* (BM, E, K, W); Algiers Sidi-bel-Abbés (nr. Oran) *Warion 114* (BM, E, W); ibid., 21 Apr. 1874, *Warion* (E, GH, K); Oran, *Balansa 535* (BM, E, K, W); Médéa, 900 m., *Gay 2395* (BM, G, GH, K).

The only other annual species of *Alyssum* occurring in the Iberian Peninsula and North Africa, and having dimorphic fruit indumentum and persistent sepals is *A. strigosum* (sect. ALYSSUM), which is frequently confused with *A. granatense* because of a similarity in habit and facies. The major differences between them are detailed in the following table:

	A. GRANATENSE	A. STRIGOSUM
LEAVES	Linear-oblanceolate, lanceolate or elliptic-oblong, grayish-green with dense indumentum of adpressed and strongly branched elliptic hairs.	Oblanceolate, or broadly obovate-spathulate, greenish with ± sparse indumentum, often strigose, of sparingly branched, or unbranched, stellate hairs.
PEDICELS	Ascending or erect, and often adpressed to main axis.	Widely divergent and patent, or horizontal.
SEPALS	Always persistent and erect, 2–3.5 mm. long, lanceolate, with ± adpressed indumentum and apical tufts of strigose hairs.	When persistent, widely spreading, 1.5–2 mm. long, ovate-elliptic, with dense overall strigose indumentum.

PETALS	Emarginate with dense strigose indumentum, 4–6 × 1.5–2 mm.	Primarily bilobed, glabrous or with sparse adpressed indumentum, 2–3.5 × 0.4–1 mm.
FILAMENTS	Very slender and wingless, edentate, and unappendaged.	Always with wide wings, teeth, and connate appendages.
FRUITS	Orbicular, up to 5 × 5 mm., values always equally inflated.	Orbicular or oblate, up to 6 × 7 mm., valves more or less unequally inflated.

From *Alyssum alyssoides*, the closest ally to *A. granatense* in section PSILONEMA, the latter is distinguished by its always larger floral parts, larger fruits, globose and reduced nectaries, erect and adpressed position of the pedicels, and the dimorphic fruit indumentum.

11. **Alyssum dasycarpum** Steph. ex Willd. Linn. Sp. Pl. ed. 4. 3(1): 469. 1800 (!). — Fenzl in Tchihatcheff. Asie Mineure Bot. 1(3): 314. 1866. — Boiss. Fl. Or. 1: 285. 1867. — Fedtschenko, Fl. Turkestan 47. 1906. — Busch in Kuznetsov, Busch & Fomin, Fl. Cauc. Crit. 3(4): 600. 1909; in Fl. U.R.S.S. 8: 358. 1939. — Popov, Man. Fl. Tashk., fasc. 1–2. *fig. 221.* 1923–1924. — Post & Dinsmore, Fl. Syr., Palest. & Sinai, ed. 2. 1: 88. 1932. — Bornmüller, Repert. Sp. Nov. Beih. 89(1): 58. 1936. — Thiébaut, Fl. Lib.-Syr. 1: 71. 1936. — Grossheim, Fl. Kavk. ed. 2. 4: 218. *tab. 25, fig. 5.* 1950. — Parsa, Fl. Iran 1: 742. *fig. 616.* 1952. — Karjagin in Fl. Azerbaid. 4: 274. 1953. — I. V. Pavlov (Ed.), Fl. Kazakh. 4: 282. *tab. 35, fig. 9.* 1961. — Dudley, Notes Bot. Gard. Edinb. 24(2): 157. *fig. 1B.* 1962. — Rech. Ark. Bot. 5(1): 168. 1963. — Ball & Dudley in Flora Europaea 1: 299. 1964. Holotype, Russia, in Siberia ad Kamam et Volgam fluvium, *Stephan s.n.* (LE, non vidi); isotypes (BM, G–DC, K).

Annual, with many erect stems, up to 25 cm. long, rarely prostrate. *Indumentum* ± dense, of coarse stellate hairs with long and few (but branched) rays, often appearing strigose. *Leaves* decreasing in size upward; the upper attenuate, obovate to oblong-oblanceolate, 7–11(–25) × (2.5–)4–9 mm., the lower wide spathulate and short petiolate, 20–35 × 12–15 mm. *Inflorescence* racemose or paniculate, up to 15 cm. long, often branching widely. *Pedicels* (1.2–)1.5–2 mm. long, divergent to ascending, often subappressed to the rachis, with dense strigose and dimorphic indumentum. *Sepals* 2–3 mm. long, ± persistent, with dense dimorphic and strigose indumentum. *Petals* obovate-spathulate, bifid or retuse, 2.5–3(–3.8) mm. long. *Filaments* 2–2.5 mm. long. *Fruits* elliptic-obovate or orbicular, truncate, 2.5–3(–4) × 2.5–3 mm.; valves equally inflated with thick flattened margins (ca. 1.5–2 mm. wide), and with dense dimorphic indumentum. *Styles* (1–)1.5–2 mm. long, stout, strongly dilated

at bases, and with dense dimorphic indumentum on the lower half. *Seeds* wingless. $2n = 16$. *Fl.* Mar.–June. Two varieties are recognized:

A. Inflorescence elongate and many-flowered; plants erect; leaves oblanceolate to obovate. ..... a. Var. *dasycarpum*.
A. Inflorescence condensed, few-flowered; plants prostrate; leaves broadly spathulate. ..... b. Var. *minus*.

a. Var. **dasycarpum**. PL. II, FIGS. b, h. PL. III, FIG. c. PL. IV, FIG. c.

Psilonema dasycarpum (Steph. ex Willd.) Meyer in Ledebour, Fl. Alt. **3**: 150. 1831 (!); in Ledebour, Fl. Ross. **1**: 127. 1842; Ic. Pl. Fl. Russ. **3**: *tab. 202*. 1831. — Fedtschenko, Fl. Ross. Austro-Orient. **5**: 44. *pl. 388, fig. B*. 1931.

Alyssum calycinoides Hausskn. in Bornmüller, Repert. Sp. Nov. Beih. **89**(1): 58. 1936, pro syn. (!).

DISTRIBUTION AND HABITAT: widespread in disturbed and ruderal habitats, roadsides, fallow cultivated fields, vineyards, limestone ridges and screes, and steppe throughout southwestern Asia, including Caucasia, Turkey, Syria, Palestine, Iraq, Iran, Transcaspia, Afghanistan and Pakistan; alt. 100–2600 m.

Turkey. A2(E): Prov. Istanbul, Kalamiche, 7 June 1916, *Aznavour* (G); Serai-koi, *Frizaldszky s.n.* (WU). A4: Prov. Çankiri, valley of Çakmakli dere, 800–900 m., 1929, *Bornmüller 18860* (E, G, K), *13859* (BM, GH, K). A6: Prov. Tokat, Tokat, *Aucher 4096* (BM, G, K, OXF). A7: Prov. Gümüşane, Gümüşane, Guans nr. Sobran (Kovans), 1894, *Sintenis 6143* (BM, G, E, K, W); ibid., 9 June 1862, *Bourgeau* (W). A8: Prov. Erzurum, Horasan nr. Hopik, 1600 m., *Davis 29378* (A, BM, E, K); ibid., Beibout (Bayburt), May 1843, *Huet* (G). A/B8: Prov. Gümüşane Erzurum, Bayburt-Erzurum, valley of Kassuklu, 1524–1829 m., May 1853, *Huet* (BM, K). B3/4: Prov. Ankara, Ankara-Polatli, 40 km. from Sakarya, 13 km. SW. of Polatli, 720 m., *Huber-Morath 13732* (HM). B4: Prov. Ankara, Angoradur Monasteri, Ankara, 10 May 1907, *Frères E. C.* (G); ibid., *Kotte 1019* (K); Prov. Konya, Yavsan Memlehasi, nr. Tuz Gölü, *Davis 18706* (E, K); Prov. Niğde Konya, Sultanhani-Cihanbeyli, 4 km. from Halkanli W. side of Tuz Gölü, 1000 m., *Dudley, D. 35927* (A, E). B5: Prov. Kayseri, Inceşu Develi, 3 km. S. of Inceşu, 1050 m., *Huber-Morath 10984* (HM); ibid., Çalasse (Talas) nr. Kayseri, *Balansa 489* (G, W); ibid., Erdschias dagh (Erciyas dağ), Lerca dağ nr. Kononia, 1600 m., May 1902, *Zedebour* (W); Prov. Kayseri Yozgat, Kayseri-Yozgat, Koprülü, 1200 m., 1890, *Bornmüller 1936* (BM). B6: Prov. Sivas, 4 km. W. of Sivas, 13 June 1939, *Reese* (HM). B7: Prov. Erzincan, Erzincan nr. Albuschikchan, 1890, *Sintenis 2176*, sub *A. calycinoides* (W); Prov. Erzurum, Erzurum, *Zohrab 375* (K). C2: Prov. Denizli, Tavas-Denizli, 800–900 m., *Dudley, D. 35560a* (A, E). C4: Prov. Konya, Konya, 4 June 1937, *Reese* (HM). C5: Prov. Niğde, Niğde-Ulukişla, S. side of pass, 47 km. from Ulukişla, 1450 m., *Huber-Morath 12818* (HM). C4: Prov. Konya, Konya, *Post 14* (G); ibid., Çumra, Kücük köy, *Helbaek 2406* (E); ibid., 4 km. from Konya, nr. Sille, 1040 m., *Huber-Morath 9277* (HM). Armenia, Erzurum-Tokat, *Aucher 4098B* (G); ibid., *Aucher 4098A* (G, W); *Calvert & Zohrab 45–p.p.* (OXF). Anatolia, *Noë 947* (G). **Syria.** Hafar-

Syrian desert, 100 m., *Dinsmore 20309* (E, K); Nebk, *Davis 5527* (A, BM, E, K); Damascus, Learnid Atiyeh, *Post 1109* (BM); Jebel Abur Rejmein, 2 May 1900, *Post* (BM, G, K); S. of Jarud, 180 m., *Dinsmore 22478* (K). **Transjordan.** Above Wadi Musa, — Moan, 1219 m., *Davis 8677* (A, BM, E, K); Ein Musa, 1372 m., *Davis 8884* (BM, E, K). **Iraq.** 18 km. W. of Suleimani, 825 m., *Eig & Zohary* (HUJ, non vidi); Moan, Moan-Ain Musa, 18 Apr. 1929, *Eig et al.* (G, W). Kurdistan, Oguhah, *Graham s.n.* (K). **Iran.** Bakhtiari, Oregon, Damane-Kuh range, 2300 m., *Wendelbo 1726* (BG, E); Prov. Khorasan, Turbat-e-Haidari, 1300 m., *Rechinger 4329* (G, W); ibid., *Rechinger 4362* (K, W); Robat Safid, 1800–2000 m., *Rechinger 7336* (W); nr. Kaswin, 3 May 1882, *Polak* (E, G, W); ibid., 1200 m., *Schmid 5044* (G); ibid., 1200–1300 m., 1902, *Bornmüller 6233* (BM, G, W); Prov. Fars, Shiraz-Kazerun, *Gauba & Sabeti 197* (W); Chiraz (Shiraz), *Aucher 4091* (G, K, OXF); Shiraz-Persepolis, 800–1000 m., *Schmid 5518* (G); Prov. Kerman/Fars, Saidabad-Cafut, 1900 m., *Rechinger 3194* (G, W); Prov. Shahrud/Bustam, Khosh-Jaila, ca. 73 km. from Shahrud, 2000–2200 m., *Rechinger 5442* (G, W); Prov. Hamadan, Aq Bulaq, ca. 100 km. N. of Hamadan, *Rioux & Golvan 212* (W); Abedeh-Daulatabad, 1500–2000 m., *Schmid 5323* (W); 5 miles N. of Daulatabad, 1372 m., *Cowan & Darlington 1096* (K); Mt. Elburs, Keredj, *Rechinger 244* (K, W); Scharabad, May 1858, *Bunge* (G, GH, K); *Tabriz, Gilliat-Smith 1773–1782* (K); Keredj, 16 May 1934, *Gauba* (W); Emirabad, nr. Ibrahirabad, 1829 m., *Cowan & Darlington 588* (K); 10 miles E. of Zorab, 1219 m., *idem 1775* (K); 20 miles W. of Zorab, *idem 1734* (K); Sultanabad, 1524 m., *Lindsay 31* (BM); Isphahan, *Aucher 4091A* (G, K, W); Isphahan-Teheran, May 1859, *Bunge* (G); Transcaspian, Aschabad, Annaju-Gjaurs, 1900, *Sintenis 51* (BM, G, GH, E, K, W); Persia, 1825, *Belanger* (G); ibid., *Kotschy 183* (G). **Afghanistan.** Herat, 1100 m., *Köie 4163* (W); Obeh, 1600 m., *Köie 4164* (W); Kabul, Kabul-Tangi Gharu, 1700 m., *Gilli 1076* (W); E. of Kabul, Budchak, 1770 m., *Gilli 1075* (W); Prov. Bamian, Band-i-Amir, Lake Band-i-Panir, 2800 m., *Rechinger 18394* (W); 2800–2900 m., *Rechinger 18226* (W); *Wendelbo 4783* (BG, E); 2900 m., *Wendelbo 4761* (BG, E); 3200 m., *Volk 2767* (W). Afghanistan/Iran. Hari Reid Valley-Khorasan, *Aitchison 194* (BM, G, GH, E, K); Jouvnal-Sinab, *Griffith 299* (K); *Griffith 1366* (K, W). **Baluchistan.** Peskin, 1525 m., *Lace 3574* (E, K); 1600 m., 17 Apr. 1888, *Lace* (E); W. Baluchistan, Ziaret, 2338, *Stewart 28087* (MICH); Nichara, *Stocks 910* (K). **Russia.** Caucasus, *Bunge 75* (K, W); ibid., Talüsch nr. Swant, *Meyer 1601* (G, K); ibid., 9 May 1947, *Grubner* (BM); ibid., nr. Codshadoi, Swant, June 1838, *Hohenacker* (BM, G, GH, K); nr. Khabadian, 610–914 m., 1883, *Regel, p.p.* (BM); Transcaucasus, Nachitschevan, dist. Dzulfa, Darry-Dagh-Dzhulfa, Apr. 1934, *Karjagin* (A); Erivan, *Buhse 118* (G, W); Azerbaidjan, dist. Salma, Dehrman, 2 Apr. 1828, *Szovits* (G); Turkistan, Chuma, *Karoliff & Krause s.n.* (G); Transcaspian, Kisil Arsah, 1885, *Becker* (K, W); in deserto Caspio, *Pallas s.n.* (BM); Caspium nr. Astrachan, 1819, *Fischer* (G–DC, K); Astrachan, 1820, *Steven* (G–DC); Soviet Armenia, Kotairk region, Vokhchabad, Darabulal 26 May 1956, *Mulkidzhanyan* (BM, E); Vedi region, Arazdian-Kiarki, 29 June 1960, *Takhtajan et al.* (BM, W); Kazakh S.S.R., Prov. Syr-Dariia, Perovsk, Akkum Tashk, desert, 11 May 1916, *Tsintserling* (A); Prov. Semiretschensk, Karatal river, 4 May 1902, *Saposhnikov* (BM, GH); Turkmenian S.S.R., dist. Krasbovodsk, steppe nr. Kizil Arvat, *Androsov 2565* (GH); Siberia, Songarei, *Schrenk s.n.* (G, GH); Soongoro-Kirghisici, nr. Ajagus, *Karelin & Kiriloff 73* (BM, E, GH, K); Siberia, *Pallas s.n.* (BM); Altai, *Ledebour 302* (G, W); ibid., *Politons s.n.* (E, W); Russia/China, Songaria Chin, Lake Saisang-Nor, *Meyer s.n.* (E, GH, K, W).

From all the other oriental species in section PSILONEMA, *Alyssum dasycarpum* may be distinguished by the dimorphic and strigose fruit indumentum, longer and basally dilated styles, and wingless seeds. The always orbicular fruits of *A. granatense* from the Iberian Peninsula and North Africa are at least twice the size of those of *A. dasycarpum*. Also, the tuberculate hairs on the fruits of the western European species are sparser and longer, resembling more those of *A. hirsutum* (sect. ALYSSUM). *Alyssum strigosum* (sect. ALYSSUM) is sometimes confused with *A. dasycarpum* because of the similar dimorphic fruit indumentum. However, the fruits of *A. strigosum* are larger and are covered with longer furcate hairs. In addition, the winged, dentate and appendaged filaments, larger floral parts, winged seeds, and widely divergent pedicels are diagnostic for *A. strigosum*. No specimens which have winged seeds have been found throughout the range of *A. dasycarpum*. A plausible explanation for the Ukranian *A. dasycarpum* var. *pterospermum* (Bordz. Bull. Jard. Bot. Kiev 7–8: 17. 1928) is that unless the seeds are examined under magnification, the lighter colored and often translucent radicle may be misinterpreted as a wing formation.

b. Var. **minus** Bornm. ex Dudley, Notes Bot. Gard. Edinb. 23(2): 157. *fig. 1A*. 1962 (!). Holotype, Iran, inter Ispahan et Hamadan, ad pagum Mohammedi, 1800 m., 17 Mar. 1892, *Bornmüller 2174* (E); isotypes (BM, G, K, OXF, W).

DISTRIBUTION AND HABITAT: a scattered and limited distribution in desert and fallow lands, and stony hillsides of Syria and Iran.

Syria. Nebk-Quaryatein. 5 Apr. 1890. *Post* (BM). **Iran.** Ispahan-Yesd nr. Bambis, 1900 m., 1892, *Bornmüller 2173* (G); nr. Kom, 1100 m., 1892, *Bornmüller 2175* (BM, E, G, K, OXF, W); nr. Dalechi, *Kotschy 181* (BM, G–p.p., K, W); Uenak ne. Teheran, *Kotschy 64* (G, W); Karawanseri, Kaswin, 30 Apr. 1892, *Pichler* (G, K, W); nr. Kaswin (Mazraeh), 1200 m., *Schmid 5048* (W); ibid., *Schmid 5007* (G); S. of Tabriz, *Gilliat-Smith 1356, 1381, 1783* (K).

Intermediate between the varieties of *A. dasycarpum*: **Iran.** Prov. Kerman. Kerman-Sultanabad, Sirdjian (Saidabad), Mashiz-Khan-e-Sorck, 2000–2580 m., *Rechinger 3006* (G, W).

12. **Alyssum homalocarpum** (Fischer & Meyer) Boiss. Fl. Or. 1: 285. 1867 (!). — Muschler, A Manual Flora of Egypt 1: 422. 1912. — Post & Dinsmore, Fl. Syr. Pal. & Sinai, ed. 2. 1: 87. 1932. — Burtt & Lewis, Kew Bull. 3: 283. 1949. — Parsa, Fl. Iran. 1: 744. 1952. — Montasir & Hassib. Ill. Man. Fl. Egypt 157. 1956. — Jafri, Notes Bot. Gard. Edinb. 22: 95. 1956. — Rech. Bot. Not. 115: 37. 1962; Ark. Bot. 5(1): 169. *fig. 14*. 1963. — Dudley in Rech. Fl. Lowland Iraq 306. 1964.

Psilonema homalocarpum Fischer & Meyer, Ind. Sem. Hort. Petrop. 6: 63. 1840 (!). Holotype, semina in Arabia Petraea, May 1837, *Schimper* (LE, non vidi — cultivated in Hortus Petropolitanus from seed collected by

Schimper). Authentic specimens (ex hb. Gay) cultivated (1837) in Jardin Luxembourg from the same seed collection have been examined in the herbaria of G, GH, and K.

Alyssum horebicum Boiss. Ann. Sci. Nat. Paris, II. **17**: 156. 1842 (!). Holotype, Sinai, Mt. Horeb, *Aucher 257* (P, non vidi); isotype (G).

Alyssum musili Velen. Sitz-ber. Böhm. Ges. Wissen. Prag **11**: 13. 1911 (!). — Velen. Repert. Sp. Nov. **13**: 25. 1913. Holotype, Arabia, in distr. Harara et Wudijan, Drejheme et Zerko, 1909, *Musil* (PRC).

Alyssum nomismocarpum Rech., Aellan & Esfand. Phyton **3**: 56. 1951 (!). Holotype, Persia, Prov. Lars, Hadjiabad prope Tarum, in declivibus siccis saxosis, ca. 900 m., 29 Apr. 1948, *Rechinger et al. 3272* (W); isotypes (E, G, K).

Annual, with numerous, erect but brittle stems, 5–20 cm. long. *Leaves* oblong-spathulate, 1–4(–5) × (0.5–)1–3 cm., acute, minutely denticulate above the middle, indumentum dense and ashy, of stellate hairs with ± divergent and long rays. *Inflorescence* corymbose, 4–10 cm. long with numerous patent or ascending fragile branches. *Pedicels* 1.3–2 mm. long, horizontal, with sparse indumentum. *Sepals* deciduous, 0.8–1 mm. long, with dense ashy indumentum of ± long-rayed stellate hairs. *Petals* linear-cuneate, subemarginate or entire, 0.5–1 mm. × 0.2–0.5 mm., glabrous. *Filaments* subulate, edentate, ca. 1 mm. long. *Fruits* broadly obovate, truncate, glabrous, 3–7 mm. long and wide, margins prominently papillose, and coloring reddish-purple when dry; valves equally inflated, with conspicuous venation. *Styles* 0.5–0.7 (–1) mm. long, dilated basally. *Seeds* narrowly winged. *Fl.* Feb.–Apr.

DISTRIBUTION AND HABITAT: a Saharo-Sindian species of dry silty river beds, limestone and sandy slopes, basaltic screes, sandstone, desert and calcareous cultivated lands in Egypt, Saudi Arabia, Kuweit, Palestine, Iraq, Iran, and West Pakistan; alt. (120–)200–1000(–1600) m.

Egypt. Mergheb, May 1904, *Muschler* (K); Ouadi Aschar (Wadi Isleh), 1905, *Muschler* (G); nr. Belbeyi, 1837, *Schubert* (K). **Saudi Arabia.** Arabian desert, *Schweinfurth 127* (K); Galâlah, *Schweinfurth 8* (G); Talpine camp-Hafarol Batin, 240 m., *Dickson 576* (K); ul-Arîsh, *Figari* (FI, non vidi). **Kuweit.** Batin-Mahazul, 100 miles W. of Kuweit, 120 m., *Dickson 511* (K); Wady Batin, 1219 m., *Fitzgerald 15610/3* (BM). **Syria.** Jabal-Tenf, *Gombault 1642* (P, non vidi). **Jordan.** Naqb Ishtar, *Hunting Aero Survey 16* (E). **Palestine.** 40 km. S. of Maan, 1929, *Eig & Zohary* (HUJ, non vidi). **Iraq.** ca. 400 km. W. of Baghdad, 1933, *idem* (HUJ, non vidi); Rutba-Ramadi, 15 km. from Rutba, 750 m., *Rechinger 9894* (W); 10 km. SW. of Rutba, 500 m. *Rawi 21047* (K); 18 km. S. of Rutba, 640 m., *Rawi 14637 & 14899* (K); dist. Diwaniya, 40 km. WNW. of Shabicha, 380 m., *Rechinger 13642* (W); Shabicha, 200 m., *Gillett & Rawi 6276* (K); Sharaban (Shabicha), Beluchi, Aug. 1886, *Jennings* (K); 40 km. NW. of Shabicha, 390 m., *Guest, Rawi & Rechinger 19306A* (K); As-Salman, nr. Ansab, 145 km. SE. of As-Salam (Southern desert, ad confines Saudi Arabia) 340 m., *Rechinger 13810* (W); 62 km. WNW. of Ansab, 135 km. SSW. of As-Salman, 360 m., *Rechinger 13781* (W); Darb Al' Haj, Saddi border, 360 m. *Guest, Rawi & Rechinger 19083* (K); 12 km. ESE. of As-Salman, 240 m.,

idem 18739 (K); nr. Ansab, 145 km. S. of As-Salman, *idem 1893* (K). **Iran.**[1] Shershah, Mar. 1859, *Bunge* (G, K); Prov. Baluchistan, nr. Zahedan, 600 m., *Gauba & Sabeti 196* (W); Montes Karvandar-Khash (Vasht or Kwash), Iranshahr (Bampur), 1500–1600 m., *Rechinger et al. 3958* (W). **West Pakistan.** North Baluchistan, 1902, *Landon* (BM).

This is the only glabrous-fruited representative of section PSILONEMA having deciduous sepals, and it is the only *Alyssum* with minute teeth towards the apices of the leaves. Rechinger (loc. cit.) notes and illustrates the papillose fruit margins of *A. homalocarpum*. This character, although rare in the genus, is not unique. A Greek endemic, *A. euboeum* (sect. ODONTARRHENA) also has fruits, the margins of which are papillose, especially towards the apices. The fruit size of *A. homalocarpum* varies considerably; the smallest measure circa 3 × 3 mm., and the largest 7 × 7 mm., but without any apparent geographical pattern. None of the characters said to distinguish *A. nomismocarpum* from *A. homalocarpum*, i.e., longer racemes, fragile stems, larger fruits, and shorter pedicels, indicates a satisfactory specific separation when the entire range of morphological variation is taken into consideration. Similarly, *A. musili* and *A. horebicum* do not possess sufficient discontinuities to separate them from *A. homalocarpum*.

EXPLANATION OF PLATES

PLATE I

Alyssum blepharocarpum: Holotype, *Huber-Morath 13722* (HM).

PLATE II

FIGS. a–g. Petal types, × 20: a, *Alyssum desertorum* var. *desertorum* (*Davis 27622*); b, *A. dasycarpum* var. *dasycarpum* (*Davis 29378*); c, *A. pinifolium* (*Kirk*); d, *A. minutum* (*Davis 18940*); e, *A. stapfii* (*Davis 28694*); f, *A. lepidotum* (*Davis 18391a*); g, *A. pseudo-mouradicum* (*Davis 38893*).

FIGS. h–r. Long filament types, × 20: h, *Alyssum dasycarpum* var. *dasycarpum* (*Davis 29378*); i, *A. huetii* (*Dudley, D. 35230*); j, *A. minutum* (*Davis 18940*); k, *A. xanthocarpum* (*Davis 19411*); l, *A. lepidotum* (*Davis 18391a*); m, *A. aizoides* (*Davis 20328*); n, *A. strictum* (*Sintenis 5614*); o, *A. repens* var. *trichostachyum* (*Davis 30295*); p, *A. filiforme* (*Davis 29072*); q, *A. giosnanum* (*Kühne 1381*); r, *A. pinifolium* (*Kirk*).

FIGS. s–y. Short filament types, × 20: s, *Alyssum huetii* (*Dudley, D. 35230*); t, *A. stribrnyi* (*Dudley, D. 34558*); u, *A. pseudo-mouradicum* (*Davis 38893*); v, *A. corningii* (*Siehe 241*); w, *A. minutum* (*Davis 18940*); x, *A. desertorum* var. *desertorum* (*Davis 27622*); y, *A. strigosum* subsp. *strigosum* (*Dudley, D. 34638*).

[1] Parsa, in his Fl. de l'Iran **1**: 745. 1952, records *Alyssum homalocarpum* from the Shah Sam de Lut desert of Iran, and indicates that the original publication of this record is to be found on page 326 of the Bornmüller paper titled "Aus der Pflanzenwelt des inner-Iranischen Wüstengürtels" (Repert. Sp. Nov. **40**: 1936). Bornmüller, however, does not mention *A. homalocarpum*, or in fact, any species of *Alyssum* in that particular paper.

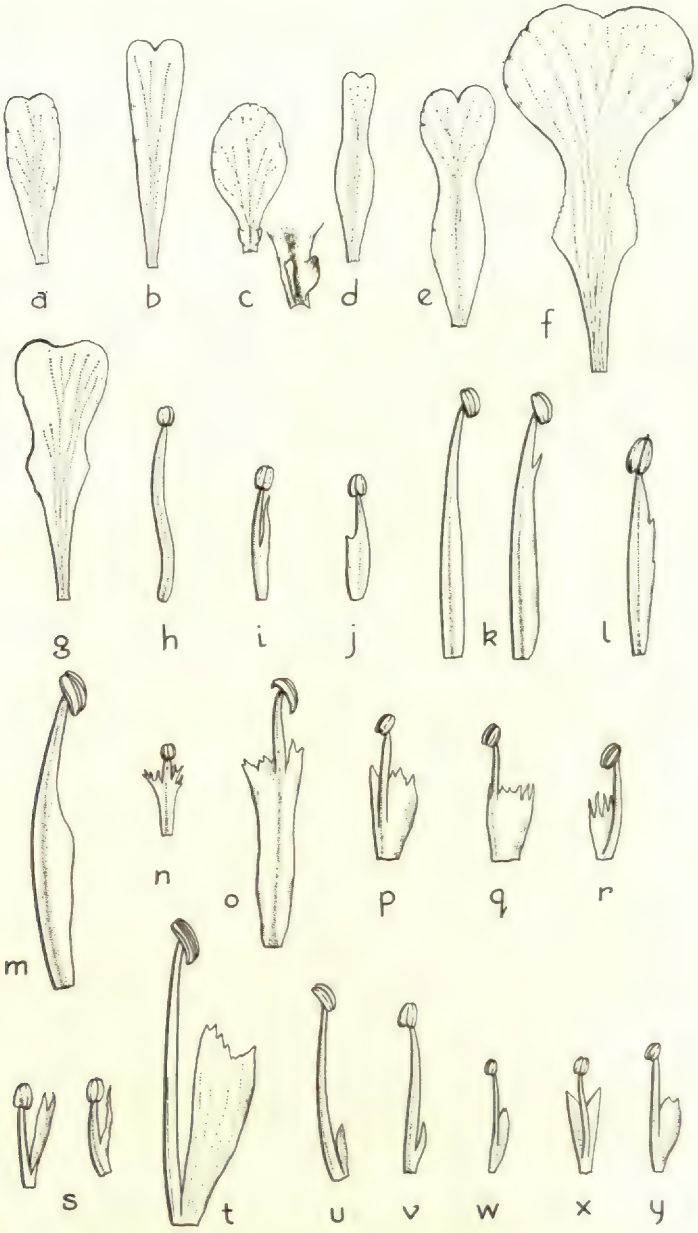
PLATE III

Fruit types. × 8: a, *Alyssum huetii* (*Dudley, D. 35230*); b. *A. desertorum* var. *desertorum* (*Davis 27622*); c, *A. dasycarpum* var. *dasycarpum* (*Davis 29378*); d, *A. xanthocarpum* (*Davis 19411*); e, *A. aurantiacum* (*Davis 16192*); f, *A. hirsutum* (*Prescott*); g, *A. szowitsianum* (*Dudley, D. 35210a*); h, *A. pseudo-mouradicum* (*Davis 38893*); i, *A. corsicum* (*Davis 13283*); j, *A. filiforme* (*Davis 31609*); k, *A. haussknechtii* (*Davis 20351*); l, *A. sibiricum* (*Dudley, D. 35860*); m, *A. murale* var. *murale* (*Dudley, D. 35551*); n. *A. cassium* (*Kühne 1446*); o, *A. crenulatum* (*Pinard*); p, *A. floribundum* (*Dudley, D. 36151*).

PLATE IV

Hair types: a, *Alyssum chondrogynum* (*Davis 3083*), from the fruit, × 200; b, *A. huetii* (*Dudley, D. 35230*), from the fruit, × 200; c, *A. stapfii* (*Davis 28694*), from the fruit, × 50; d, *A. xanthocarpum* (*Davis 19411*), from the lower leaf surface, × 50; e, *A. pseudo-mouradicum* (*Davis 38893*), from the upper surface of sterile shoot leaf, × 50; f, *A. eriophyllum* (*Haussknecht*), from leaf of sterile shoot, × 50; g, *A. strigosum* subsp. *strigosum* (*Dudley, D. 34638*), from the stem, × 50; h, *A. strigosum* subsp. *strigosum* (*Dudley, D. 34638*), from the fruit, × 50; i, *A. hirsutum* (*Prescott*), from the fruit, × 50; j, *A. corsicum* (*Dudley, D. 33283*), from the lower surface of sterile shoot leaf, × 50; k, *A. stribrnyi* (*Dudley, D. 34558*), from upper surface of cauline leaf, × 50; l, *A. aizoides* (*Davis 20328*), from upper surface of basal cauline leaf, × 50; m, *A. mouradicum* (*Balls 186*), from lower surface of basal cauline leaf, × 50; n, *A. szowitsianum* (*Dudley, D. 35210a*), from fruit, × 50.

DUDLEY, STUDIES IN ALYSSUM



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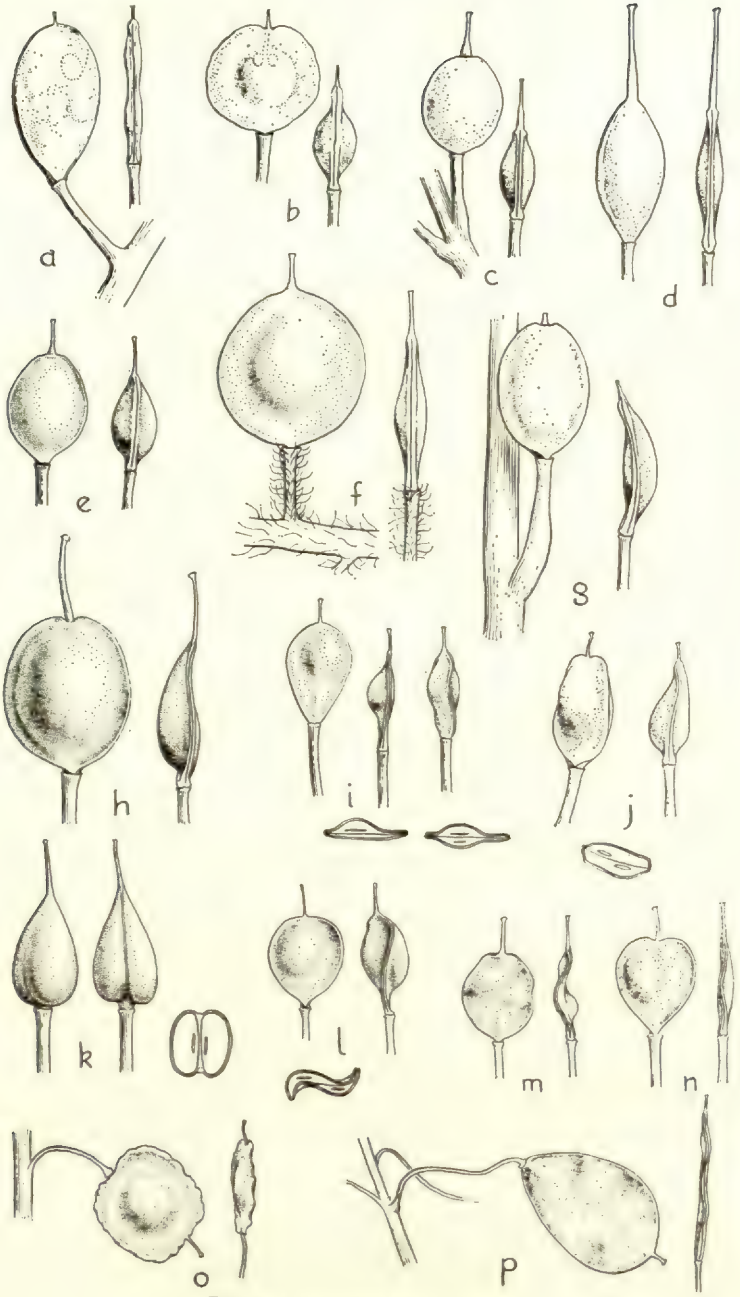

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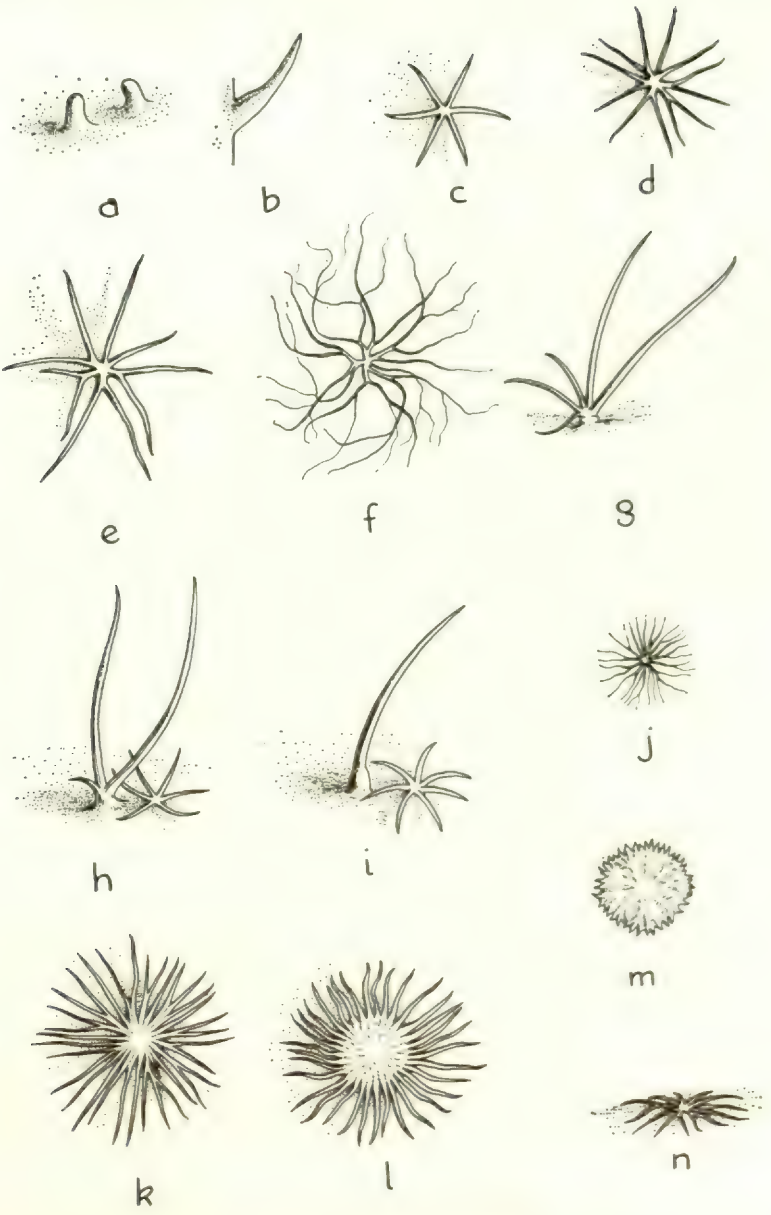

DUDLEY, STUDIES IN ALYSSUM

THE GENERA OF VALERIANACEAE AND DIPSACACEAE IN THE SOUTHEASTERN UNITED STATES [1]

I. K. FERGUSON

VALERIANACEAE Batsch, Tab. Affin. Reg. Veg. 227. 1802, nom. cons.
(VALERIAN FAMILY)

Annual or perennial herbs, sometimes woody at base. Leaves in basal rosettes or opposite, pinnately divided or entire, exstipulate, the bases often sheathing. Inflorescence a monochasium, thyrse, or many-flowered compound dichasial cyme, sometimes condensed and capitate, bracteate and bracteolate [ebracteolate]. Flowers irregular or almost regular, bisexual or unisexual. Calyx obsolete or developing late and becoming conspicuous only in fruit, annular [or toothed], adnate to ovary. Corolla tubular, 5[3 or 4]-lobed, imbricate, often basally spurred or saccate [bilabiate]. Stamens epipetalous and alternate with the corolla lobes, varying in number, usually 3 in our genera [1, 2, 3, or 4]; anthers versatile, 2- or 4-lobed, 4-locular, introrse, dehiscing longitudinally; pollen tricolpate, echinate. Gynoecium syncarpous, ovary inferior, 3-locular, with two locules usually suppressed and one fertile, with a solitary, pendulous, anatropous ovule; style 1, stigma simple or lobed. Fruit dry, indehiscent, the calyx often developing into a winged, awned, or plumose pappus. Seed 1; endosperm absent; embryo large, straight, the cotyledons oblong, the radicle superior. TYPE GENUS: *Valeriana* L.

A family of about ten genera and 370–400 species, widely distributed but occurring mainly in the North Temperate regions and absent from Australasia; three genera native and one introduced in North America; two genera in our area.

Valerianaceae are a natural family closely related to Dipsacaceae but

[1] Prepared for a generic flora of the southeastern United States, a joint project of the Arnold Arboretum and the Gray Herbarium of Harvard University made possible through the support of George R. Cooley and the National Science Foundation and under the direction of Carroll E. Wood, Jr., and Reed C. Rollins. This treatment follows the pattern established in the first paper in the series (Jour. Arnold Arb. **39**: 296–346. 1958) and continued through those in volumes 40–46 (1959–1965). The area covered is bounded by and includes North Carolina, Tennessee, Arkansas, and Louisiana. The descriptions are based primarily on the plants of this area, with any supplementary material in brackets. References which the author has not seen are marked by an asterisk.

The author is indebted to Dr. Wood for his aid and valuable criticisms; to Dr. George K. Brizicky, for his guidance and suggestions; and to Mrs. Gordon W. Dillon, for her help in the preparation of the typescript.

distinguished by the 3-locular ovary (one locule fertile), cymose inflorescences, and seeds without endosperm. The family also has affinities with the Caprifoliaceae and Rubiaceae.

Members of the family often have a very characteristic unpleasant odor. Volatile oils occurring mainly in the root and rhizome have been investigated extensively, especially in *Valeriana*.

The cytogenetics of the family have not been very fully investigated, although chromosome numbers for some species of *Valeriana* (21 species of 300) and *Valerianella* (11 species of 60) are available. However, only a few chromosome counts are reported for four additional genera: *Centranthus*, $2n = 14, 32$ (three species); *Fedia*, $2n = 32$ (one species); *Patrina*, $2n = 22$ (one species); and *Astrephia*, $2n = 32$ (one species).

The family is of little economic importance. A few members, among them *Centranthus ruber* (red valerian) and *Valeriana officinalis* (garden heliotrope or common valerian), are grown as ornamentals. The latter is used as a source of the drug "valerian." Corn salad (*Valerianella Locusta*), as its name implies, is used in salads. Spikenard (*Nardostachys Jatamansi*) yields an oil which has been used in perfumery in the East.

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KEY TO THE GENERA OF VALERIANACEAE

Calyx inrolled in flower, developing in fruit to form a conspicuous pappus with 5–15 plumose awns; fruit 1-locular; plant perennial. . . . . 1. *Valeriana*.
Calyx obsolete; fruit 3-locular; plant annual or biennial. . . . . 2. *Valerianella*.

1. **Valeriana** Linnaeus, Sp. Pl. **1**: 31. 1753; Gen. Pl. ed. 5. 19. 1754.

Perennial herbs or vines with thickened, strong-scented, fleshy [woody or tuberous] roots, sometimes stoloniferous; glabrous or sparsely hairy with short, simple hairs. Leaves petiolate to nearly sessile, basal and cauline, undivided, pinnate, pinnatifid, or ternate. Inflorescence usually a dichasial cyme or thyrse, terminal or axillary, sometimes lax or subcapitate, bracteate and bracteolate. Flowers irregular, bisexual or uni-

sexual. Calyx inrolled in flower, enlarging and developing in fruit to form a pappus with short, sessile, patelliform, membranaceous limb and 5–15 plumose awns [or the limb cupuliform and irregularly dentate]. Corolla funnelform or campanulate [salverform or rotate], the tube slightly saccate at the base [or straight], usually more or less hairy in the throat, 5[3 or 4]-lobed. Stamens 3 [rarely 4], inserted toward the top of the corolla tube, usually exserted (but included in *V. scandens*); anthers 2- or 4-lobed. Stigma simple or 3-lobed; ovary 3-locular, with two locules suppressed and one fertile with a solitary ovule. Fruit a unilocular, compressed achene with 3 nerves on the outer and 1 on the inner surface. LECTOTYPE SPECIES: *Valeriana pyrenaica* L.; see Britton & Brown, Illus. Fl. No. U. S. ed. 2. 3: 284. 1913. (Name Medieval Latin, from *valere*, to be strong; said also to be named for the Roman emperor Valerianus).

A genus of about 300 species of Europe, Asia, Africa, and America, centered mainly in the temperate regions of the Northern Hemisphere and the mountains of South America; eleven species in the United States, two in our area.

Of the seven sections recognized by Höck, six (*Pseudiastrephia* Höck, *Hybocarpus* Höck, *Valerianopsis* Wedd., *Phyllactis* Pers., *Porteria* Hook., and *Aretiastrum* DC.) are entirely South American and have been variously treated by different authors as distinct genera or as sections within *Valeriana*. The North American species belong to sect. VALERIANA (§ *Euvaleriana* Höck). Different authors have recognized a varying number of series within this section (cf. Höck, Meyer).

The genus is well defined by the combination of perennial habit, three stamens, and inrolled calyx usually enlarging and forming a pappus on the one-locular fruit. It is probably most closely related to *Valerianella* and to *Centranthus*, which is distinguished by one stamen and spurred corolla.

Valeriana scandens L., readily recognized by its climbing habit, occurs in Mexico, Central and South America, and the West Indies, northward in peninsular Florida to a shell-mound in Duval County. It seems likely that this species is a calciphile, but it does not appear to occur on the Florida Keys. It is placed by Meyer in the *Sorbifoliae*, a series distinguished chiefly by included stamens and two-lobed anthers. Meyer recognizes two varieties (which some authors have treated as distinct species): var. *scandens*, with tripartite leaves, and var. *Candolleana* (Gard.) Muell., with entire leaves. The widespread var. *scandens* occurs in Florida, but var. *Candolleana* occurs northward only to Hispaniola and Cuba. Intermediate specimens with both entire and tripartite leaves have been found, however, both in our area and elsewhere. *Valeriana pauciflora* Michx., distinguished by its long, funnelform corolla tube and stoloniferous habit, occurs from Pennsylvania to Illinois, Tennessee, and Virginia. It is placed in the series *Officinales* Höck, separated by the rhizomatous or stoloniferous roots and four-lobed anthers.

Sexual polymorphism occurs in the genus in several ways, the plants being completely hermaphrodite, polygamous, polygamodioecious, or dioecious, with dioecism least common. The presence of unisexual as well as bisexual flowers is easily detected by the differential lengths of the corolla.

The mode of pollination appears to be unknown but is probably entomophilous. Nectaries are reported to occur in the saccate base of the corolla tube. The occurrence of proterandry assures cross-pollination in bisexual flowers.

The cytogenetics of *Valeriana officinalis*, $2n = 14, 28, 56$, has been extensively investigated, but the cytology of the genus as a whole is not well known. Chromosome numbers of $2n = 14, 16, 18, 28, 32, 56$, and 64 have been reported.

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2. **Valerianella** Miller, Gard. Dict. Abr. ed. 4. 1754.

Small annual or biennial, glabrous or pubescent herbs with dichasial branching, appearing dichotomous, but the terminal bud aborting in the lower branches. Basal leaves forming a rosette, petiolate to nearly sessile, undivided or dentate; cauline leaves connate, undivided, dentate [or rarely

incised-pinnatifid]. Inflorescence capitate, terminal, usually a dichasial cyme subtended by lanceolate to oblong, connate bracts. Flowers almost regular, bisexual [or unisexual] in the axils of lanceolate to oblong, connate bracteoles. Calyx obsolete [or forming a narrow, toothed rim]. Corolla funnelform, narrowly campanulate or tubular, the tube slightly saccate at the base, 5-lobed. Stamens 3, inserted toward the top of the corolla tube, exserted, anthers 4-lobed. Stigma simple or shortly 3-lobed; ovary 3-locular, one locule fertile with a solitary ovule. Fruit glabrous or pubescent, 3-locular, two of the locules empty, the other 1-seeded. LECTOTYPE SPECIES: *Valeriana Locusta* L. = *Valerianella Locusta* (L.) Betcke; see Britton & Brown, Illus. Fl. No. U. S. ed. 2. 3: 286. 1913. (Name a diminutive of *Valeriana*.)

A genus of temperate parts of the Northern Hemisphere, including about 60 species in two sections; 19 in North America, ten in our area.

The shape, relative size of the sterile locules, and indumentum of the fruits are the most important characters used to distinguish the species. The indumentum of the plant and the shape of the bracts (rounded, pointed, or acuminate) are also important characters. Specimens with both fruit and flowers are necessary for the determination of species.

Four species of sect. SIPHONELLA Krok, marked by salverform corollas and strongly glandular fimbriate-serrulate bracts, occur in the southeastern United States. *Valerianella Bushii* Dyal and *V. ozarkana* Dyal are strictly calciphile and known only from Arkansas and Missouri, while *V. Nuttallii* (Torr. & Gray) Walp. and *V. longiflora* (Torr. & Gray) Walp. are known only from western Arkansas and eastern Oklahoma. The other six species of our area belong to sect. VALERIANELLA, with funnelform corolla and glabrous bracts with entire or ciliate margins. *Valerianella Locusta* (L.) Betcke (*V. olitoria* (L.) Poll., *Valeriana Locusta* L. *a olitoria* L.), $2n = 14$, an introduced European species widely scattered throughout our area, is readily recognized by the corky mass on the fertile locule of the fruit. *Valerianella umbilicata* (Sulliv.) Wood and *V. patellaria* (Sulliv.) Wood occur from North Carolina and Tennessee, northward to New York, Ohio, and Illinois. They are distinguished from the other species in the section by the breadth of the sterile locules in comparison with the fertile locule of the fruit. *Valerianella intermedia* Dyal, which ranges from Massachusetts to Kentucky and Illinois, occurs in scattered localities in North and South Carolina, apparently as an introduction. It is closely related to *V. radiata* (L.) Dufr., a widespread, polymorphic species occurring throughout our area and extending to Pennsylvania, Kansas, and Texas. *Valerianella Palmeri* Dyal, occurring only in Arkansas, appears to be closely related to *V. intermedia* but is separated by its longer fruit with abortive sterile locules.

Some authors have thrown doubt on the validity of some of the species recognized in North America. Dempster has found dimorphism in the fruits of species of the closely related *Plectritis* and has revised the taxono-

my of that genus. In view of this, the species pairs *Valerianella Bushii–V. ozarkana* and *V. umbilicata–V. patellaria* need further investigation, for in each pair the two sometimes grow together, show a similar, limited geographical distribution, and are distinguished by their fruits.

There is a lack of cytological information relating to North American species of *Valerianella*. Chromosome numbers of $2n = 14, 16, 18, 32$ have been reported for European and Asiatic species. The method of pollination appears to be unknown; insect visitors have been observed and self-pollination reported to occur.

Valerianella has affinities with *Valeriana*. It is very closely related to *Fedia* and *Plectritis*, and early authors treated these variously as one or more genera. More recent authors have treated *Fedia* as a monotypic Mediterranean genus distinguished by its irregular corolla, two stamens, and dimorphic fruits. *Valerianella* is separated from the predominantly western North American *Plectritis* by the typically 3-locular ovary, 3-lobed stigma, and dichotomously branched inflorescence *vs.* the 1-locular ovary, 2-lobed stigma, and capitate or interruptedly spicate inflorescence.

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DIPSACACEAE A. L. de Jussieu, Gen. Pl. 194. 1789, "Dipsaceae," nom. cons.
(TEASEL FAMILY)

Mostly perennial herbs, the flowers bisexual, irregular, with a calyx-like involucel of fused bracteoles, and borne in the axils of imbricate receptacular bracts, the calyx small [variable], the corolla gamopetalous, 4[5]-lobed, the stamens 4 [5], inserted toward the top of the corolla tube, and the ovary inferior. TYPE GENUS: *Dipsacus* L.

An Old World family of about eight to twelve genera and 250–300 species, centered in the Mediterranean and Near East, extending to North Europe, East Asia, and South Africa. About ten species in the genera *Dipsacus*, *Cephalaria*, *Scabiosa*, *Knautia*, and *Succisa* are naturalized in North America; one species of *Dipsacus* occurs in our area.

Dipsacaceae are placed in the Rubiales by most authors and appear to be a very natural family, with the exception of the isolated genus *Morina*, which some authors have placed in a separate family. Dipsacaceae have close affinities with Valerianaceae. The family is distinguished from Valerianaceae by the unilocular ovary and by the capitate inflorescence surrounded by an involucre of bracts, characters which suggest affinities with Compositae.

Chromosome numbers of $2n = 10$, 14, 16, 18, 20, 34, 36, 38, 42, 43, 44, 46, 50, 54, and 64 have been reported. Ehrendorfer has suggested that the basic chromosome number of the family is $x = 9$ and that euploidy, aneuploidy on the diploid level, polyploidy followed by aneuploidy, gene-, chromosome-, and genome-mutations have been important in the evolution of Dipsacaceae.

The variation in the receptacular bracts and the diverse development of the involucel and calyx are connected with fruit dispersal and give good characters for taxonomic division of the family into genera.

The family is of little economic importance. A few genera are of horticultural interest, and *Scabiosa* is widely cultivated for its ornamental value.

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1. **Dipsacus** Linnaeus, Sp. Pl. 1: 97. 1753; Gen. Pl. ed. 5. 43. 1754.

Stout, erect, biennial herbs with spiny or prickly stems. Leaves simple, entire [to pinnately divided], opposite, exstipulate; basal leaves petiolate, stem leaves connate [petiolate]. Inflorescence a head with 1 or 2 rows of

linear to lanceolate [narrowly triangular], subulate, erect or speading, spine-tipped involucral bracts; each flower subtended by a chaffy receptacular bract and surrounded by a 4-angled tubular involucel of fused bracteoles, which is grooved with a median rib and truncate at the apex, with an almost obsolete denticulate margin. Calyx cup-shaped, 4-angled, with a ciliate margin. Corolla imbricate, lobes often unequal. Stamens 4, alternate with the corolla lobes, exserted; filaments free; anthers 4-locular, introrse, longitudinally dehiscent; pollen tricolpate, echinate. Stigma lateral, entire; style filiform; ovary unilocular, ovule solitary, anatropous, pendulous from the apex of the locule. Fruit indehiscent, dry, inclosed within the calyx-like involucel and crowned with the persistent calyx. Seed 1; endosperm fleshy; embryo straight, the cotyledons oblong or ovate, the radicle superior. Embryo sac development of the normal (Polygonum) type. LECTOTYPE SPECIES: *D. fullonum* L.; see Britton & Brown, Illus. Fl. No. U. S. ed. 2. 3: 289. 1913. (Name from Greek, *dipsa*, thirst, because the united cup-shaped bases of the leaves in some species hold water.) — TEASEL.

About 12 species of Europe, western Asia, and Africa, three naturalized in North America. *Dipsacus fullonum* L. (*D. sylvestris* Huds.),[2] $2n = 16$, 18, a native of Europe, is probably widespread and scattered throughout the United States, occurring sporadically in our area. *Dipsacus fullonum* has close affinities with *D. sativus* (L.) Schkuhr (*D. fullonum* auct. non L.), $2n = 16$, 18, also a native of Europe, locally naturalized in the northeastern United States. The involucral bracts curve upward in *D. fullonum* and the receptacular bracts end in a long straight spine, while in *D. sativus* the involucral bracts spread more or less horizontally and the receptacular bracts end in a stiff, recurved spine. Some authors have treated *D. sativus* as a subspecies of *D. fullonum*. The very different laciniate-leaved *D. laciniatus* L. is established in the northeastern United States.

The genus is mainly a well-defined one recognized by the presence of stem prickles and spine-tipped bracts. It is most closely related to *Cephalaria*, which is also distinguished from the rest of the family by chaffy receptacular bracts and a four-angled involucel. Grenier and Godron placed *D. pilosus* L. in *Cephalaria*, but few subsequent authors have adopted this treatment.

The mode of flowering in the genus is characteristic, the flowers opening first about halfway up the head and developing in sequence both upward and downward.

The species are separated on the basis of the leaves, which may be connate or stalked, entire or divided; the inflorescence, which may be oblong, ovate, or globose; and the involucral bracts, which may be linear-lanceolate, subulate, keeled with spines on the margins and midrib, or narrowly triangular, shorter or longer than the inflorescence.

[2] The application of the name *Dipsacus fullonum* L. will be discussed in the next issue of this Journal.

The ripened inflorescences of *D. sativus*, the fuller's teasel, are used in fulling cloth (raising the nap), and the plants are grown to a limited extent for this purpose.

The flora and fauna of the rain water caught by the connate leaf bases have been studied more or less extensively, but most biological aspects of the genus have been neglected.

Chromosome numbers of $2n = 16, 18, 36$ have been reported.

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Arnold Arboretum
and
Gray Herbarium

A PRELIMINARY REPORT ON FUNIFERA

LORIN I. NEVLING, JR.

THE EARLIEST RECORDED INFORMATION concerning the plants now recognized as members of the thymelaeaceous genus *Funifera* C. A. Mey. was published in 1820 (Atti Soc. Ital. Sci. Modena 18: 391), by the Italian botanist Raddi. In that publication, by means of a rather sophisticated and complete description, Raddi defined a new Brazilian species of *Daphne*, *D. brasiliensis* (to be transferred below to *Funifera*). In nearly a century and a half which has since elapsed, our knowledge of this and related species has not increased much; the chief contribution being descriptions of a few additional species.

At the suggestion of Mr. Guido Pabst, Director of Herbarium Bradeanum, I started what was intended to be a comprehensive revision of the genus *Funifera*. However, the poor quality of most of the existing collections (i.e., flowers and fruits lacking from most of the sheets) has frustrated such a project. I hoped the difficulties would be at least partially overcome when I had a large suite of specimens assembled. Since, however, the additional material was not very satisfactory I am presenting as a report the information now available, hoping it may serve as an outline for field work and eventual new collections which will make possible a precise and detailed study.

The species of the genus *Funifera* are not conspicuous components of the vegetation in the areas of Brazil where they grow; nor are they of great economic importance even at the local level. They are intriguing because so little is known of their geographic and ecologic distribution, their anatomy, and their morphology. In addition, the medicinal potential of these plants found in references from folk-medicine, has both practical and theoretical application in modern phytochemistry.

Various properties attributed to plants of the genus *Funifera* are similar to those ascribed to other genera of the Thymelaeaceae. The tough cortical fibers of *Funifera* are employed as cordage (Penna, 1946) a common practice in related genera of the family throughout the geographic distribution. The fibers of the American genera are never used in paper making, this use being restricted entirely to the Old World members of the family. A decoction of the macerated bark of *Funifera* is used externally as a vesicant (Dragendorff, p. 204. 1898) in the same manner as that of *Daphne mezereum* L. of Europe. If accidentally ingested the decoction is especially caustic to the mucous membrane of the mouth. Other American Thymelaeaceae known to have a similar vesicating effect are *Daphnopsis* (one species has the common name "Burn Nose"), *Dirca*, and *Ovidia*.

A decoction of the leaves of *Funifera* may be used internally as an

emetic or cathartic according to Hoehne (pp. 204, 205. 1939). Similar results may be obtained also from the New World genera *Daphnopsis*, *Dirca*, *Lagetta*, *Lasiadenia*, and *Ovidia*. Based on a very limited number of reports, in *Daphnopsis*, *Dirca*, and *Ovidia*, such a decoction, or the comparable use of fruits, should be avoided as it presents more than a little danger to the patient (both violent illness and death have been reported). Hoehne (p. 206. 1920) says that *Funifera* is "extremamente toxicas." He further notes that cattle are adversely affected by grazing both *Daphnopsis* and *Funifera* and are stricken particularly from May to September (during the vegetative growth phase).

An active principle has not been isolated but several compounds, mezerein, daphnin, and umbelliferone, have been reported in several genera of the Thymelaeaceae. Hoehne (p. 206. 1920; p. 204. 1939) has reported both mezerein and daphnin present in *Funifera*. If these compounds, or chemically related ones, are more consistently present in the family than has been realized, they may provide the chemical basis for the similarity of application found in folk medicine throughout the world. The chemical composition of mezerein is unknown, most authorities referring it to the category of an "acrid resin." Both umbelliferone and daphnin belong to a large group of related compounds having coumarin (for a most informative paper on this compound see Brown, 1963) as a nucleus. Since the coumarin derivatives are found in many groups of plants their use as supplemental taxonomic characters is less important than might have been expected. Umbelliferone is known to absorb ultraviolet light and has been used as sunburn protection, and as a whitening agent in soap powders. Specific uses for daphnin have not been reported. Coumarin has been used commercially as an adulterant or substitute for vanilla, as an adulterant of tobacco, and in the perfume trade. It has a fragrant odor and burning taste. A coumarin derivative could account, in part, for the peculiar and distinctive odor of many thymelaeaceous plants. In general, coumarin is considered nontoxic to mammals although Pammel (p. 552) points out that "Dr. Millspaugh states that in large does. [it] causes nausea, vomiting, vertigo, great depression of the heart's action and cold extremities." Dean (p. 241) further states that . . . "larger animals (e.g., dogs, horses) can be killed by coumarin, but moderate quantities have no very marked effect on man except that it has been reported recently that coumarin has a true curare-like activity." It is impossible to say whether a single compound or a group of compounds is responsible for the similarity of medicinal uses to which thymelaeaceous plants are put but the latter alternative seems more likely. It is clear that more precise diagnostic and physiological data are needed for all the compounds mentioned.

MATERIALS

This study is based on specimens from the following herbaria, the abbreviations for which are taken from Lanjouw & Stafleu's *Index Herbariorum, Part I*. Ed. 5 (Regnum Vegetabile, 31. 1964).

A	Arnold Arboretum of Harvard University, Cambridge, Massachusetts [1]
BM	British Museum (Natural History), London
E	Royal Botanic Garden, Edinburgh
F	Chicago Natural History Museum, Chicago
FI	Herbarium Universitatis Florentinae, Firenze
G–DC	Herbier DeCandolle, Conservatoire et Jardin botaniques, Genève
GH	Gray Herbarium of Harvard University, Cambridge, Massachusetts [1]
HB	Herbarium Bradeanum, Rio de Janeiro
K	Royal Botanic Gardens, Kew
L	Rijksherbarium, Leiden
LE	Herbarium of the Komarov Botanical Institute of the Academy of Sciences of the U.S.S.R., Leningrad
M	Botanische Staatssammlung, München
MO	Missouri Botanical Garden, St. Louis
NY	New York Botanical Garden, New York
P	Muséum National d'Histoire Naturelle, Paris
PI	Istituto Botanico della Università, Pisa
R	Divisão de Botânica do Museu Nacional, Rio de Janeiro
RB	Jardim Botânico, Rio de Janeiro
S	Naturhistoriska Riksmuseum, Stockholm
US	U.S. National Museum (Department of Botany), Smithsonian Institution, Washington

I wish to thank the directors and curators of the institutions listed for allowing me to examine the specimens in their care. Special thanks are given to Mr. Guido Pabst whose encouragement was responsible for my carrying the study to this stage.

TAXONOMY

Funifera C. A. Mey. Ann. Sci. Nat. Paris II. **20**: 46, 47, 49. February, 1843 (TYPE SPECIES: *Lagetta funifera* Mart. & Zucc.); Bull. Acad. St. Pétersb. Classe Physico-Math. 1: 355, 357. June, 1843.

Neesia Mart. ex Meissn. *In*: Mart. Fl. Bras. **5**: 67. 1855, non Blume. *pro syn.*

Dioecious shrubs with flexible leathery branches, the stems often dichotomously branched, the cortex containing many fibers. Leaves irregularly pseudo-whorled, opposite, subopposite, or rarely alternate, simple, entire, pinnately veined, petiolate, estipulate. Inflorescences usually borne from the younger leafy or bracteate shoots, umbelliform or racemiform. Flowers unisexual, tetramerous, perigynous; calyx tube cylindrical or urceolate, the interior villous below and glabrous above; calyx lobes much shorter than the tube, in unequal pairs, generally erect at anthesis; petals 0; disc of 8 free lobes or the lobes connate and coronate. Staminate flowers: stamens 8, in two whorls, the upper 4 antisepalous, included to exserted, the lower 4 alternisepalous, included, the anthers longitudinally dehiscent, introrse, basifixed; pistillode present, densely villous. Pistillate

[1] The abbreviation A–GH, used for citation of certain microfiches, refers to the collection in the combined library of the Arnold Arboretum and the Gray Herbarium, Harvard University.

flowers: staminodia 8 or 0, the upper whorl sometimes bearing aborted anthers; pistil 1, superior, the ovary uniloculate with 1 anatropous ovule, the style eccentric, the stigma obscurely bilobed or capitate, included or exserted. Fruit a berry enclosed by the persistent and accrescent calyx tube.

KEY TO THE SPECIES

a. Mature leaves 4 to 7 times longer than broad, narrowly elliptic to oblanceolate, 4–14 cm. long, 1–2.5 cm. broad, densely sericeous beneath.
   b. Leaves irregularly pseudo-whorled, opposite, subopposite or rarely alternate, the apex acute and often minutely apiculate; staminate inflorescences 5–6-flowered, the primary peduncle ca. 3 mm. long, stout; disc of the staminate flowers with 8 free lobes; pistillate flowers with 8 staminodia. ..... 1. *F. brasiliensis.*
   b. Leaves subopposite or alternate, the apex long acuminate; staminate inflorescences 10–35-flowered, the primary peduncle 10–35 mm. long, slender; disc of the staminate flowers coronate, the lobes connate below; pistillate flowers unknown. ..... Species A (Incertae sedis).

a. Mature leaves about 3 times longer than broad, elliptic to oblanceolate or obovate, sparsely sericeous beneath.
   c. Leaves elliptic, 8–12 cm. long, 2.5–4 cm. broad, glabrous above, the apex subacute (nearly blunt); disc of the staminate flowers with 8 free lobes; pistillate flowers lacking staminodia. ..... 2. *F. ericiflora.*
   c. Leaves oblanceolate to obovate, 9–21 cm. long, 3–7 cm. broad, glabrescent above, the apex acute or abruptly acuminate; disc of the staminate flowers coronate, the lobes connate below; pistillate flowers with 8 staminodia. ..... 3. *F. grandifolia.*

1. **Funifera brasiliensis** (Raddi) Nevl. comb. nov.

Daphne brasiliensis Raddi, Atti Soc. Ital. Sci. Modena **18:** 391. 1820 (TYPE: *Raddi s.n.*! PI).
Lagetta funifera Mart. & Zucc. Nov. Gen. & Sp. **1:** 64, *t. 39.* 1824, ex char.
Funifera utilis Leandro ex Mart. & Zucc. *Ibid., pro syn.*
Funifera utilis Leandro ex C. A. Mey. Ann. Sci. Nat. Paris II. **20:** 46, 47, 49. February, 1843; Acad. St. Pétersb. Classe Physico-Math. **1:** 357. June, 1843.
Daphne thereminii Lhotzky ex Meissn. in Mart. Fl. Bras. **5:** 67. 1855, *pro syn.*
Neesia daphnoides Mart. ex Meissn. *Ibid., pro syn.*

Much branched shrub, to 2 m. tall, the branchlets reddish brown, rugose, minutely but densely sericeous and soon glabrescent. Leaves [alternate,] subopposite, opposite, or irregularly pseudo-whorled (3–7 leaves per whorl), the blade oblanceolate or narrowly elliptic, 4–11(–14) cm. long, 0–2(–2.5) cm. broad, acute and sometimes minutely apiculate at the apex, tapered to the base, glabrous above, ochraceous sericeous beneath, the costa immersed above, elevated beneath, the primary lateral veins inconspicuous, dark green above (appearing light to dark red-brown on drying), light green beneath (ochraceous when dry); the margin revolute; petiole

ca. 3 mm. long. Inflorescences borne from the apical leafy whorls, the bud scales numerous subtending the inflorescence, lanceolate, 2–5 mm. long, glabrous above, sericeous beneath. Staminate inflorescence: 5–6 flowers per inflorescence, umbelliform, sericeous throughout, primary peduncle ca. 3 mm. long, the rachis 0, the secondary peduncles ca. 4 mm. long. Staminate flower: pedicel 0.5–1.5 mm. long; calyx tube cylindrical, 7–8 mm. long, 1–1.5 mm. in diameter at the orifice, white sericeous without, villous within in lower two-thirds and glabrous in upper one-third; calyx lobes unequal, the deltoid set 1 × 0.5 mm., the ovate set 0.75 × 0.5 mm., puberulent within; petals 0; antisepalous stamens inserted at the orifice, exserted, the alternisepalous stamens inserted about the length of 3 anthers below the orifice, included, the anthers subsessile, oblong, 0.5–0.75 mm. long, 0.25 mm. broad; disc of 8 free lobes, the lobes linear, 1.5–2 mm. long, glabrous, occasionally 2 lobes connate at the base; pistillode fusiform, ca. 0.5 mm. long, long-villous. Pistillate flower: pedicel obsolete; calyx tube cylindrical, 8 mm. long, 2.5 mm. in diameter at the orifice, white, densely sericeous without, densely villous within in lower two-thirds, glabrous in upper one-third; calyx lobes deltoid, unequal, 1.5 × 2 mm. and 1 × 1 mm., minutely puberulent within; petals 0; staminodia 8, in two whorls, the upper whorl with aborted anthers, the lower whorl (often hidden by trichomes) papilliform; disc of 8 free lobes, the lobes linear with a slight swelling at the apex, 2.5 mm. long, glabrous; ovary ovoid, ca. 2.5 mm. long, densely villous, the style eccentric, 3.5–4 mm. long, villous, the stigma obscurely bilobed, barely exserted. Fruit enclosed by the accrescent papery calyx tube, the tube urceolate, to 12 mm. long, the berry obpyriform, ca. 5 mm. long, 4 mm. in diameter, white, the style and stigma often persistent.

Flowering from December through May. Fruiting specimens infrequent. Common names: Embira branca, Embira sebo, Pau de embira, Imbira branca (also used for *Apeiba cimbalanea* of the Tiliaceae), and Imbira (a common name shared with several species of the genus *Daphnopsis*).

Brasil.[2] GUANABARA: Rio, *Doellinger s.n.* (M), *Gardner 812* (E, GH, K, NY, P), *5597* (BM, E, GH, K, US), *Gaudichaud* "1832" (P), *Glaziou 860* (F, K, P), *2487* (BM, K, P), "1872" (FI), *Luschnath* "1835" (LE), *Martius s.n.* (K, L, M), *Riedel 23* ["1829"] (LE, NY), *552* ["1832"] (A, LE, NY, US), *553* ["1823"] (A, LE, US), *Saint-Hilare 757* (P), *Weddell 92* (P), "1843" (P); [Trovasi nei Boschi in vicinanza di Rio-Janeiro, e segnatamente presso *Matacavallos*], *Raddi s.n.* (PI-holotype of *Daphne brasiliensis*); Alta do Bôa Vista, *Brade 10640* (GH, R), *10641* (GH, R); Estrada da Vista Chinesa [road from Mesa do Imperador to Alto da Bôa Vista], *Brade 15015* (RB); Corcovado, *Aparicio & Rizzini 11* (RB), *Gaudichaud 79* (P), *Glaziou 20473* (K, P, US), *Guillemin* "1839" (K, P), *Lhotsky* "1832" (G–DC; microfiche, A–GH), *Miers 3256* (BM, K, P, US), *Nadeaud* "1862" (P), *Schwacke 7149* (RB), Mata das Obras Publicas, perto da Cotia, prósimo da séde do H. Florestal, *Kuhlmann* "1930" (RB, mixed with *Daphnopsis utilis*);

[2] I am departing from my usual custom of noting the sex of the specimens cited, for too frequently in collections of *Funifera* it is impossible to recognize.

Mata do Horto Florestal, Lourenço "1922" (RB), Parque da Cidade, Gavéa, *Duarte 5204* (A, HB), Mata da Lagouinha, *Dionisio & Constantino* "1917" (RB); Suamaré, *Pereira, Liene, Sucre & Duarte 4143* (A, HB); Morro do Grajáu, *Filho 574* (R); Morro de Babilonia, *Guillemin* "1839" (P), Serra Carioca, *Brade 10715* (R), *Occhioni 364* (RB); in the ascent from the head of the valley of Catumbé, up the high mountain on the n.w. side of the Aqueduct of Carioca, *Burchell 1840* (K); along the Aqueduct, *Burchell 858* (K), *1245* (K); up the path by the side of the aqueduct Monta da Santa Theresa, *A. C. [Allemão Cysneiros]* "1875" (BM); Tijuca, Trapicheiro [lee side of Serra da Carioca], *Netto* "1870" (R), *Valle 96* (R); Corcovado Mountain, by way of Laranjeiras, *Burchell 1449* (L), *Gardner 812* (BM, K). RIO DE JANEIRO: Cabo Frio, *Netto, Glaziou & Schwacke s.n.* (R). Without precise locality: *Langsdorff & Riedel 606* (LE), *Leandro do Sacremento 8* (M), *Lépine s.n.* (P), *Lund 169* (G–DC; microfiche A–GH), *Martius 416* (K, MO, P), "1823" (G–DC; microfiche, A–GH), *s.n.* (L), *Weddell* "1844" (P), *s.n.* (P), *Widgren 485* (S), *Sello s.n.* (BM, K). Locality questionable: Ceará, *Cysneiros 1347* (R); Para, *Vincent* "1915" (L).

Several manuscript names appearing on specimens of this species have been published as synonyms. The two pistillate sheets of *Martius s.n.* deposited at Munich bear the name "Neesia daphnoides" and are the basis for that name. The microfiche of this collection from the DeCandolle herbarium (G-DC) shows one specimen, *Lhotsky* "1832," bearing the name "Daphne Thereminii." Both of these names were published by Meissner as synonyms in Martius' Flora Brasiliensis. Another sheet in the DeCandolle herbarium, *Martius* "1823," bears an unpublished name.

Several problems have arisen in connection with the geographic distribution of *Funifera brasiliensis*. It seems to me that the plants are restricted to the Carioca, Tijuca, and Gavéa ranges with a disjunct population, to the north, at Cabo Frio. The single collection from the last named locality is fragmentary but appears to be this species. Positive determination must await collection of flowering material. Several cryptic reports indicate that the species occurs as far south as São Paulo but I have seen no material to support the claim. In addition, José Correa Gomes, Jr., Curador do Herbário, has written that no material of the genus is on deposit at the Instituto de Botânica, São Paulo.

I have listed *Allemão Cysneiros 1347* as being from a questionable locality. The specimen bears three labels: one, a handwritten label with "Lagetta funifera (Mart.)" and the family name; a second label with the collector's name and title (M. N. PLANTAS DA COMM. SCIENT. DO CEARÁ.) printed, the collector's number (*1347*) and identification handwritten; the third label is recently printed and typewritten. Cysneiros collected in the state of Ceará from 1859 to 1861. It is not at all clear whether the label is associated with the proper plant, for this locality is not in accord with the range of *Funifera brasiliensis* as understood at this time. A second sheet, with the initials A. C., which I assume to have been collected by the same man, in 1875, is from "Rio."

A specimen at Leiden, collected by Vincent in 1915, marked "Para" is questionable. Surely "Para" refers to a local name and not to the state

of Pará, but I have not found such a locality within the known range of the species.

The collections of Ludwig Riedel have been cited by number and year of collection to avoid confusion. His two earliest Brasilian collections were not numbered; his subsequent collections (four excursions) were each independently numbered. A note explaining this system plus a biographic discussion can be found in Urban's "Biographische Skizzen. II. 2. Georg Heinrich v. Langsdorff (1774–1852) und 3. Ludwig Riedel (1790–1861)" Beibl. Bot. Jahrbüch. **44**: 6–21. 1894 (see especially p. 20).

In this species, *Funifera brasiliensis*, growth seems to occur in flushes, with stem elongation and flower production taking place simultaneously. Following anthesis, one or more axillary buds subtending the inflorescence develop and form the peculiar branched structure characteristic of the shrubs of this species. Shortly after the lateral vegetative shoots elongate, the leaves mature and the plants enter a resting phase.

Notes on several herbarium specimens indicate the possibility of development of an enlarged underground stem in older specimens. It is believed that these underground stems would be advantageous for survival in areas subject to frequent burning. This adaptation occurs in several African genera but is suspected only in a few cases involving American Thymelaeaceae.

2. **Funifera ericiflora** (Gilg & Markgraf) Domke, Biblioth. Bot. **111**: 57. 1934, in text.

Daphnopsis ericiflora Gilg & Markgraf, Repert. Sp. Nov. **19:** 113. 1923 (TYPE: *Hoehne 2112*).

Shrubs, the branchlets puberulent and glabrescent, yellow-brown. Leaves opposite, the blades elliptic, 8–12 cm. long, 2.5–4 cm. broad, subacute at the apex, acute to obtuse at the base, thin-coriaceous, glabrous above, very sparsely sericeous beneath, costa nearly plane above and beneath, lateral veins many, submarginal vein present, margin not thickened; petiole ca. 3 mm. long. Staminate flowers (fide Gilg & Markgraf): borne in axillary fascicles; pedicel 3–4 mm. long, nodding; calyx tube ellipsoid-campanulate, sericeous without, the interior villous below, glabrous above; calyx lobes short, anthers subsessile; disc of 8 lobes, the apices laciniate; pistillode rudimentary, obovate, sericeous. Pistillate flowers: pedicel obsolete; calyx tube urceolate, ca. 6.5 mm. long, 1 mm. in diameter at the orifice, sericeous without, densely villous within in lower portion, upper part glabrous; calyx lobes deltoid, 1.0 × 0.5 mm. and 0.75 × 0.5 mm., puberulent within; petals 0; staminodia 0; disc of 8 free lobes, linear, ca. 1.5 mm. long, glabrous, the apices somewhat swollen; ovary ovoid, densely villous, ca. 1.5 mm. long, the style filiform, eccentric, 3.5 mm. long, glabrous, the stigma capitate, included. Fruit not known.

Flowering in June and November. Hoehne has remarked "interessante per cause da fibra que contem a casca." No common names are known.

Brasil. MATO GROSSO: Juruena, *Hoehne 5504* (R).

There is scarcely any information available about *Funifera ericiflora* which was not presented by Gilg and Markgraf at the time of their original diagnosis. Only diligent collecting can provide us with fruiting material, more and better specimens of flowering material, and a fuller knowledge of the geographic and ecologic distribution of this species.

3. **Funifera grandifolia** Domke, Notizbl. Bot. Gart. Berlin 12: 731. 1935 (TYPE: *Kuhlmann* 14 Nov. 1922! RB).

Shrubs to 3 m. tall, the branchlets minutely sericeous and glabrescent, greenish brown. Leaves alternate to subopposite, the blades oblanceolate to obovate, 9–21 cm. long, 3–7 cm. broad, acute or abruptly attenuate at the apex, cuneate at the base, membranaceous, glabrescent and darker green above, minutely sericeous and paler beneath, the costa immersed above, elevated beneath, the primary lateral veins many, inconspicuous, submarginal vein present, the margin not thickened; petiole 5–7 mm. long. Inflorescences borne from the young growth, solitary; each inflorescence 8–18-flowered, umbelliform, canescent, the primary peduncle 3–12 mm. long, the rachis ca. 1 mm. long, the secondary peduncles 5–8 mm. long. Staminate flowers: pedicel 1–4 mm. long; calyx tube cylindrical, 4.5–8 mm. long, 1–2.5 mm. in diameter at the orifice, white, densely puberulent without, long-villous within in the lower one-third, glabrous in the upper two-thirds; calyx lobes nearly dentate, ca. 1 mm. long, to 0.5 mm. broad, puberulent within; antisepalous stamens inserted at the orifice, exserted, the alternisepalous inserted about the length of 3 anthers below the orifice, included, the anthers oblong, 0.5–1 mm. long, ca. 0.25 mm. broad, the filaments 0.25–1 mm. long, glabrous; disc coronate with 8 attenuate lobes, 1–1.5 mm. long, glabrous; pistillode densely villous. Pistillate flowers (fide Domke): similar to staminate flowers with the following exceptions: staminodia 8, filamentous; disc to 0.5 mm. long; ovary ovoid, ca. 3.5 mm. long, villous, the style filiform, ca. 5 mm. long, villous on lower portion, the stigma small, round, semi-included or included. Fruit unknown.

Flowers in November.

Brasil. RIO DE JANEIRO: Serra de Friburgo, Fazenda Valerio, *Kuhlmann*, 14 Nov. 1922 (RB No. 21335); in sylvis primaevis. Machi. *Riedel 553* (LE).

In Domke's diagnosis of this species a good description of staminate and pistillate flowers is presented. The holotype, which I have examined, is without flowers now; it has been remounted since publication of Domke's diagnosis and several errors appear on the typewritten label.

Domke has indicated that this may be the plant which was listed (Ann. Sci. Nat. Paris II. 20: 49. February, 1843; Bull. Acad. St. Pétersb. Classe Physico-Math. 1: 357. June, 1843) by C. A. Meyer as *Funifera latifolia* Fisch. & Mey. (a *nomen nudum*). A concurring annotation, by A. Smirnova, is on the Leningrad collection.

INCERTAE SEDIS

Funifera species A.

Small shrub, the stems slender, sparsely sericeous and tardily glabrescent, reddish brown. Leaves alternate or subopposite, the blades narrowly elliptic, 5–12 cm. long, 1.5–2.5 cm. broad, long acuminate at the apex, cuneate at the base, membranaceous, glabrous (except sparsely sericeous along the margin) above, sericeous beneath, dark green above (light brown on drying), light green beneath (ochraceous on drying), the costa immersed above, elevated beneath, the primary lateral veins inconspicuous, the margin slightly thickened; petiole 2–5 mm. long, shallowly canaliculate, sericeous. Inflorescences borne from the older stems, axillary or extra-axillary. Staminate inflorescence: 10–35 flowers per inflorescence, racemiform, sericeous throughout, the primary peduncle 1–3.5 cm. long, the rachis 0.5–2 cm. long, the secondary peduncles 2–7 mm. long, dilated at the apex; linear bracteole inserted near the summit of the primary peduncle, deciduous. Staminate flowers: pedicel 1–1.5 mm. long; calyx tube cylindrical, 6–7.5 mm. long, ca. 1 mm. in diameter at the orifice, white, sericeous without, long villous within in lower one-fourth, glabrous upper three-fourths; calyx lobes linear-deltoid or deltoid, 1 × 0.5 mm., and 0.75 × 0.25–0.5 mm., puberulent within; petals 0; filaments 0.25–0.5 mm. long, the antisepalous whorl inserted about the length of 1 anther below the orifice, subexserted or included, the alternisepalous whorl inserted the length of 3–4 anthers below the orifice, included, the anthers linear, 0.75 mm. long, 0.25 mm. broad; disc coronate, 1.75–2 mm. long, glabrous, with large linear lobes; pistillode fusiform, 2–3 mm. long, densely villous. Pistillate flowers and fruit unknown.

Brasil. RIO DE JANEIRO: Ilha de Paquetá, Morro da Imbuca, *Pereira 681* (RB). Without precise locality: São Domingos, Avé-Lallemant "1887" (R).

It is unfortunate that both of the specimens, which I believe represent an undescribed species, are incomplete. The plants resemble *Funifera brasiliensis* most closely but differ from it in important vegetative and floral characteristics. There is no question that better and more complete material will be collected in the future so I do not feel that it is wise to describe the species formally at this time.

EXCLUDED SPECIES

Funifera fasciculata Meissn. Mart. Fl. Bras. **5**: 68. 1835 = *Daphnopsis fasciculata* (Meissn.) Nevl. Jour. Arnold Arb. **44**: 404. 1963.

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GRISEBACH'S FLORA OF THE BRITISH WEST INDIAN ISLANDS: A BIOGRAPHICAL AND BIBLIOGRAPHICAL INTRODUCTION

WILLIAM T. STEARN

DESPITE THE PASSAGE OF TIME the *Flora of the British West Indian Islands* (London, 1859–1864) by August Heinrich Rudolf Grisebach (1814–1879) is a work which students of the Caribbean flora must necessarily often consult on account of the many new specific names and nomenclatural combinations published therein, as well as for taxonomic information. Indeed, little taxonomic work on West Indian plants can be done without reference to it. The following notes on this *Flora* were originally compiled about 1960 to form an introduction to a facsimile (*Historiae Naturalis Classica*, no. 30), which through a misunderstanding was published in 1963 without them. They deal with its dates of publication (p. 263), the area covered (pp. 260–263), the abbreviations for literature employed by Grisebach (pp. 276–285), and the collectors (pp. 264–272) whose material he cited. To these have been added a short biography of Grisebach (pp. 245–249) and a chronological list of his publications (pp. 249–260).

Historically Grisebach's *Flora* is of interest as the first of a series of British colonial floras initiated at Kew by Sir William Jackson Hooker (1785–1865). As stated in a memorandum of 1863 on colonial floras, "the publication by Government of a series of inexpensive portable 8vo works, illustrative of the vegetable products of the British possessions, has long been contemplated by the Director of the Royal Gardens of Kew. To him, in his official capacity, incessant applications for information on the vegetable products of our Colonies are made, by the Home and Colonial Governments and by private individuals, especially merchants and manufacturers; and he is habitually applied to by travellers and emigrants for the names of such books as will enable them to obtain precise information about the plants of the different Colonies." Grisebach's *Flora* was, however, "commenced before the general plan was entertained; and neither the plan, size, nor typography of the work, nor the sequence of the orders are uniform with the Floras since undertaken." Bentham's *Flora Hongkongensis* (1861) served as a model for these. It is of interest to note that the British West Indies were then estimated to possess 2,000

FIG. 1. AUGUST HEINRICH RUDOLPH GRISEBACH (1814–1879).

species, British Guiana 2,500 species, Canada 2,000 species, South Africa 10,000 species, British India 12,000 species, Ceylon 3,000 species, Hong Kong 1,000 species, Australia 8,000 species, and New Zealand 1,200 species.

The choice of the British West Indies as the first area for systematic botanic treatment in this way reflects Hooker's own personal interest. For

years before, during his professorship at Glasgow (1820–41), he had been receiving specimens and plants from his correspondents in the West Indies, notably Scots, and his eldest son had emigrated to Jamaica (where he died in 1840). One of Hooker's first acts on becoming director of the formerly private royal gardens at Kew was to send Purdie to Jamaica to get West Indian plants for the expanding Royal Botanic Gardens now open to the public. The period during which these collections were made coincided with one of economic decline in the British West Indies. As stated by Parry and Sherlock, "one disaster followed another: bankruptcy and financial chaos in the eighteen-forties, droughts and epidemics in the eighteen-fifties, rioting and bloodshed in the eighteen-sixties" (*Short Hist. West Indies*, 188. 1956). The will and means for founding institutions of higher learning existed neither among the planters nor the emancipated slaves. Encouragement for the scientific study of the plants of the British West Indies and for further collecting had therefore to come from outside the area. With the completion of Grisebach's *Flora* this external stimulus ended and local interest languished. Instead of forming the basis for yet more investigation, the *Flora* gave the impression by its apparent exhaustiveness that no further investigation was needed. Particularly did this apply to Jamaica, where between 1860 and 1880 almost all botanical activity ceased.

Renewed collecting in Jamaica, following the appointment in December, 1879, of Daniel Morris (1844–1933) as director of Public Gardens and Plantations and his founding of a Botanic Department herbarium for Jamaica, quickly demonstrated the unreality of such a view.[1] By 1909, according to Urban (Symb. Ant. 6: 84. 1909), the new botanical exploration had led to an increase of 358 species of flowering plants above those recorded for Jamaica in Grisebach's *Flora*, 285 of them being species new to science. Most of these discoveries stood to the credit of William Harris (1860–1920) who went out to Jamaica as a gardener in 1881; most of the support for his work came from the interest and encouragement of Ignaz Urban (1848–1931) in Berlin and Nathaniel Lord Britton (1859–1934) in New York.

BIOGRAPHY OF GRISEBACH

August Heinrich Rudolf Grisebach was born on 14 April 1814, at Hanover, north Germany, where his father Rudolf Dietrich Grisebach (d. 1837) was auditor general of the kingdom of Hanover. His mother's brother, the Göttingen professor Georg Friedrich Wilhelm Meyer (1782–1856), author of *Primitiae Florae Essequeboensis* (1818), *Chloris Hanoverana* (1836), and other botanical works, encouraged and directed his early interest in natural history. After schooling at Hanover and Ilfeld he entered, in the autumn of 1832, the university of Göttingen, studied botany here under H. A. Schrader and F. G. Bartling, as well as medicine,

[1] See STEARN, W. T., A botanist's random impressions of Jamaica. Proc. Linn. Soc. London **170**: 134–147. 1959.

for five terms, then moved to the university of Berlin in April 1834, to complete his studies, becoming doctor medicinae et chirurgiae in April 1836. At Berlin he came under the influence of C. S. Kunth, H. F. Link, F. J. F. Meyen, and M. J. Schleiden; as his doctoral dissertation he presented *Observationes quaedam de Gentianearum Familiae Characteribus* (Berlin. 1836), a pamphlet of 37 pages preliminary to his massive *Genera et Species Gentianearum adjectis Observationibus quibusdam phytogeographicis* (364 pages, Stuttgart & Tübingen. 1838). Already in 1833 he had botanized in southern France and had become interested in the associations of plants characteristic of regions and habitats. Alexander von Humboldt's travels inspired him as they did Charles Darwin. From Berlin he moved back to Göttingen in 1837.

In March 1839 Grisebach set out on the most important journey of his life, a botanical expedition to the Balkan Peninsula (he extended the use of the term Rumelia to cover all the central region then under Turkish rule) and north-west Asia Minor (Bithynia), which had long captivated his imagination, this region being virtually unexplored from the botanical standpoint and little known in other aspects. He left Vienna on 2 April 1839, and travelled by water to Istanbul (Constantinople), first down the Danube to Tulcea (Tuldscha) and Sulina, then south along the Black Sea coast of the Balkan Peninsula to Istanbul where he arrived on 17 April. As interpreter, servant, and cook he engaged a reliable Greek who spoke fluently Turkish, Greek, Arabic, French, and Italian and travelled with him, by way of Üsküdar (Scutari), Kartal, Yalova, and Gemlik (Kemlik) to Bursa (Brussa) which they reached on 2 May. Four days later Grisebach climbed to the snowline of the Ulu Dağ (Olympus Bithyniae). He distinguished on this mountain three main zones of vegetation: the region of sweet chestnut (*Castanea*), ca. 50–2500 feet, the region of conifers, 2500–4600 feet, the alpine region, 4600–6920 feet. He then returned to Istanbul, visiting Mudanya (Modania) on the way. Back in Istanbul he met Fortunato Pestalozza, an Italian doctor from Milan, who later sent him and also Boissier many specimens from Asia Minor. Grisebach left Istanbul on 18 May, then travelled westward, by way of Tekirdağ, to Enez (Enos) in Thrace, reaching this on 25 May and leaving it on 30 May. He then went on to Maronia (Marogna), taking ship from here to the island of Thasos (Tassos) and thence to Athos (Hajion-Oros), where he stayed from 3 June to 12 June surveying its vegetation. He then crossed Khalkidhiki, by way of Kholomonda (Cholomonda) to Thessaloniki (Salonichi). This he reached on 16 June and left on 24 June, from here travelling northwestward to Edhessa (Vódena) in Macedonia, thence to Bitola (Monastir, Bitolia), Prilep (Perlepe), Skopje (Ueskueb), Tetovo (Tettova) and Kalkandele at the foot of the Šar Planina (Scardus). On 14 July he made an ascent of Scardus reaching the peak (2496 meters high) of Ljuboten (Ljubatrin) on 17 July and Kobelica (Kobelitza, 2526 meters high) on 22 July. This survey provided both many observations on the altitudinal zoning of vegetation and many specimens of hitherto unknown species. His route now took him from Prizren (Prisdrén) westward over

north Albania to Shkoder (Scutari), which he reached on 27 July, leaving on 31 July for Lastua at the southern tip of Dalmatia. Here his Rumelian journey ended. In three months he thus covered a transect of the Balkan Peninsula between 40° and 42° N. and from sea-level to 2526 m.

The scientific results of this journey across Thrace, Macedonia, and Albania, made when Grisebach was 25 years old, entitle it to rank in botanical history with the celebrated journey into floristically unknown Lapland made a little over a hundred years earlier by Linnaeus at the age of 25. His *Reise durch Rumelien und nach Brussa im Jahre 1839* (2 vols., Göttingen, 1843–46) gives a general account of his travels. His *Spicilegium Florae Rumelicae et Bithynicae* (2 vols., Brunswick, 1843–45) is a systematic enumeration of the plants then collected, its value as a pioneer flora of the Balkan Peninsula being increased by the inclusion of plants collected here and in Bithynia by Friedrichsthal, Frivaldzki and Pestalozza, and by references to those described by Buxbaum, Sibthorp and Smith, and others. This journey laid that foundation of first-hand knowledge of types of European vegetation on which Grisebach built his later phytogeographical work culminating in his *Vegetation der Erde* (1872). In 1842 he made a journey to Norway in order to become acquainted with northern vegetation; this provided the material for his paper "Über den Vegetationscharacter von Hardanger" in Wiegmann's *Archiv für Naturgeschichte* **10**: 1–28. 1844.

Late in 1847 Grisebach became full professor (professor ordinarius) of botany in the medical faculty of the University of Göttingen, having been a privatdocent there from 1837 to 1841, associate professor (professor extraordinarius) since 1841, and here he remained during the rest of his life, for his loyalty to Göttingen, which during its hundred years of existence had become a leading academic center of Germany, led him to decline the offer of professorships elsewhere, i.e. at Giessen in 1846, at Leipzig in 1851 and again in 1866, at Berlin in 1851, at Munich in 1855, and at St. Pétersbourg in 1855.

Although Grisebach's monographic work on Gentianaceae had extended his studies far beyond the European flora, his travels and his collections naturally concentrated his attention mostly on European plants. For a long time, however, he had wished to investigate the vegetation of a tropical area with the aid of extensive material. The tragic death of W. G. Walpers in 1853 led him to Caribbean botany. Walpers possessed a large collection of herbarium specimens, enriched with notes and drawings, which had been made in Guadeloupe, Panama, and St. Thomas by the Guadeloupe-born French doctor and naturalist, Placide de Fontbressin Duchassaing (1818–1873). He gave this valuable material to Walpers for publication, but Walpers, who had evidently become mentally disordered, did nothing worthwhile with it and after his suicide Grisebach purchased it all. In the course of determining Duchassaing's plants Grisebach catalogued not only these but also all the other species recorded in the literature from the West Indian islands between 15° and 19° N., i.e. between Martinique and St. Thomas. He published this list in 1857 as

"Systematische Untersuchungen über die Vegetation der Karaiben insbesondere der Insel Guadeloupe" (Abhandl. Kön. Ges. Wiss. Göttingen (Phys.) 7: 151–286). "About the same period," as Grisebach states in the preface to his *Flora of the British West Indian Islands*, "Sir W. Hooker was exerting himself to procure the publication of a complete series of Colonial Floras . . . and consequently entrusted the elaboration of the present volume to myself, putting all the materials of the Hookerian Herbarium and the Kew Museums at my disposal, and procuring a grant of £300 to meet the necessary expenses. . . . Four times I went over to England, to compare my own West Indian herbarium with that at Kew; whilst all those forms which proved not to be in my possession were most liberally placed in my hands to be examined at Göttingen. . . . For a series of doubtful West Indian plants mentioned by older authors I have, when sojourning in London, consulted the Banksian collection of the British Museum, but not to as great an extent as might have been desirable. All those Swartzian species, however, which I had no opportunity of seeing there, were kindly sent for inspection by Professor Andersson, of Stockholm, and these proved most important . . . the only authentic information as to certain Swartzian species is to be derived from his originals, either in the possession of the Academy of Stockholm, or of the British Museum."

This *Flora of the British West Indian Islands* was "intended to be a synopsis of all vascular plants as yet known to inhabit the British West Indian possessions." The descriptions were accordingly made as concise as possible, synonymy was kept to a minimum and, in general, only illustrations were cited. Keys were omitted and distribution only briefly indicated. Grisebach toiled at it intensively, continuously, and rapidly, and its completion was a remarkable achievement. He was a very able botanist, but the work swarms with mistakes, some due to the insufficiency of material but most of them attributable to the high speed with which it was prepared; Urban has noted that his errors are especially numerous among species with very small flowers, which require time-consuming observation. While engaged on this task Grisebach received a set of specimens collected in eastern Cuba by Charles Wright (1811–1885). This material and observations made while working on the Flora led him to publish two important papers in 1860, namely, "Erläuterungen ausgewählter Pflanzen des tropischen Amerikas" (Abhandl. Kön. Ges. Wiss. Göttingen (Phys.) 9: 3–58) and "Plantae Wrightianae, e Cuba Orientali." Pars 1 (Mem. Am. Acad. Arts & Sci. N.S. 8: 503–536). He never visited the West Indies himself, and the greater part of them had yet to be explored botanically. In 1865 he published a paper on "Die geographische Verbreitung der Pflanzen Westindiens" (Abhandl. Kön. Ges. Wiss. Göttingen (Phys.) 12: 3–80) summarizing phytogeographical information as then available. According to this, the known flora consisted of about 4400 species of flowering plants and 400 of vascular cryptogams, the endemic species being apportioned as follows:

CUBA	849	species	MARTINIQUE	2	species
JAMAICA	275	"	GUADELOUPE	1	"
TRINIDAD	83	"	ST. LUCIA	1	"
DOMINICA	29	"	ANTIGUA	1	"
ST. VINCENT	12	"	BARBADOS	1	"
MONTSERRAT	2	"	BAHAMAS (including		
GRENADA	2	"	TURKS ISL.)	18	"

These figures are low because some of the areas rich in endemic plants had then scarcely been entered by botanical collectors. The known West Indian flora consists of about 10,000 species of phanerogams and 600 of vascular cryptogams.

Work on Philippi's and Lechler's collections from southern Chile and the Straits of Magellan (see Abhandl. Kön. Ges. Wiss. Göttingen (Phys.) **6**: 89–138. 1856) and on the Malpighiaceae of Central America and Brazil gave him an acquaintance with the flora of the American mainland. This was extended further by the receipt for naming of big collections of Argentinian plants made by Paul Günther Lorentz (1835–1881) [2] and by Georg Hieronymus (1846–1921) [3] which he catalogued in "Plantae Lorentzianae" (Abhandl. Kön. Ges. Wiss. Göttingen (Phys.) **19**: 49–278. 1874) and "Symbolae ad Floram Argentinam" (Abhandl. Kön. Ges. Wiss. Göttingen (Phys.) **24**: 3–346. 1879).

Meanwhile Grisebach had become the world's leading authority on plant geography, partly through his own field-work, partly by the study of herbarium collections from many lands, partly through the analysis of innumerable floristic and geographical publications. Already in 1838 he had published a paper in *Linnaea* (**12**: 159–200. 1838) "Über den Einfluss des Climas auf die Begränzung des natürlichen Floren." and from 1841 to 1856 he published yearly reports on plant geography and systematic botany. He brought together the fruits of this study in his monumental *Die Vegetation der Erde nach ihrer klimatischen Anordnung* (2 vols., Leipzig. 1872), translated into French as *La Végétation du Globe d'après sa Disposition suivant les Climats* (2 vols. Paris. 1875–78). This and the *Flora of the British West Indian Islands* are his most important single contributions to botanical literature. In 1878, at the age of 64, he began an even more ambitious undertaking, a *Flora Europaea*, of which he wrote the text relating to Ranunculaceae, Berberidaceae, Papaveraceae and part of Cruciferae during the winter of 1878–79, but which his death on 9 May 1879, from Bright's Disease, prevented him from publishing even in part. The fragment was, however, published by Agost Kanitz, in 1882, under the title *Reliquiae Grisebachianae*.

CHRONOLOGICAL LIST OF GRISEBACH'S PUBLICATIONS

[The following list of Grisebach's publications is extracted from the "Biographische Nachrichten über A. Grisebach und Bibliographie seiner

[2] See "Zur Erinnerung von Dr. Paul Gunther Lorentz" by A. Stelzner in Beih. Bot. Centr. **9**: 450–468. 1882.

[3] See obituary by R. Pilger in Hedwigia 62. Heft. 5–6 [unpaged] 1921.

Werke" by his son, the diplomatist Eduard Grisebach, appended, as pages 605–628, to his posthumous *Gesammelte Abhandlungen und kleinere Schriften zur Pflanzengeographie* (Leipzig. 1880). Some quotations are here omitted. To increase its utility a few supplementary details, enclosed within brackets, have been added.]

Noch als Student hatte er veröffentlicht:

1. Die bei Hannover wachsenden Giftpflanzen. (Hannöver'sches Magazin. Jahrgang 1834).
2. Bericht über eine botanische Reise nach dem Dauphiné und der Provence im Herbste des vorigen Jahres; von Herrn *Grisebach* in Göttingen. (Allgem. botanische Zeitung Nr. 21, Regensburg am 7. Juni 1834. p. 321–334). [i.e. Flora (Regensburg) **17:** 321–334]

Die Doctor-Dissertation ist betitelt:

3. Observationes quaedam de Gentianearum familiae characteribus. Dissert. inaug. quam . . . publice defensurus est auctor *Aug. Henr. Rud. Grisebach.* Berolini, typis Nietackianis. (37 pp.).

In dem nämlichen Jahre (1836) schrieb er ferner:

4. Some remarks on the germination of Limnanthemum lacunosum (Ann. Nat. hist. I. p. 6–12). [1838]

[4b. Some remarks on the genus [Erythraea]. (Ann. Nat. hist. I. p. 438–439. 1838)]

5. Gentianeae Americae borealis (in: *Hooker*, Flora boreali-americana). [**2:** 54–71; July 1837]
6. Gentianeae Americae australis (in: *Hooker*, Contributions).

Die Monographie der Gentianeen führt den Titel:

7. Genera et Species Gentianearum adjectis observationibus quibusdam phytogeographicis auctore *Aug. Henr. Rud. Grisebach.* Stuttgartiae et Tubingae, sumtibus *J. G. Cottae*, 1839. (VIII & 364 pp.). [Published at end of 1838. Listed in Allgemeine Bibliogrbl. Deutschl. 3 no. **42:** 585 (19 Oct.) 1838; "the work had actually reached the London booksellers, near a month before the end of 1838." (cf. Bentham, in London Jour. Bot. **4:** 232. 1845.)] Das Werk ist gewidmet "Viro illustrissimo Sir *W. J. Hooker*, fautori studii Gentianearum generosissimo hunc qualemcunque libellum grati animi tesseram observantissime dico." Den grösseren Theil des Buches hatte er noch in Berlin, auf dem botanischen Garten in Schöneberg, ausgearbeitet, die Vorrede ist jedoch schon von Göttingen (15. Mai 1838) datirt, wo er sich seit Michaelis 1837 als Privatdocent niedergelassen hatte.

Im Jahre 1838 gab er ferner zum Druck:

8. Über den Einfluss des Climas auf die Begränzung der natürlichen Floren. (Linnaea. XII. p. 159–200). [Reprinted in item 139, pp. 1–29 (1880)]
9. Über Luftröhrenhaare (ibid. p. 681–685). [i.e. Grisebach & Hoffmann, Beobachtung der Luftröhrenhaare bei Limnanthemum Gmelin und Villarsia Venten. op cit.]
10. Malpighiacearum Brasiliensium Centuriam (ibid. XIII, p. 155–259).
11. *Alph. de Candolle*, Introduction à l'étude de Botanique. Paris 1835. (Recen-

sion — anonym — in: Göttinger Gelehrte Anzeigen vom 17. Mai 1838, p. 781–800).

12. *Raspail*, Nouveau système de Physiologie végétale et de Botanique. Paris 1837. (Recension — anonym — ibid. 20. September 1838, p. 1489–99).
13. *Dutrochet*, Mémoires pour servir à l'histoire anatomique et physiologique des végétaux et des animaux. Paris 1837. (Recension — anonym — ibid. 20. u. 22. October 1838, p. 1668–80 u. 1683–86).
14. *Hegetschweiler*, die Flora der Schweiz. Zürich 1838 (Recension — anonym — ibid. 10. Nov. 1838, p. 1796–1800).
15. *Benj. de Lessert*, Icones selectae plantarum. tom. III. Paris 1837. (Recension — ibid. 6. Dec. 1838, p. 1929–38).
16. *Kunth*, Flora Berolinensis. Berlin 1838. (Recens. ibid. 29 Decemb. 1838, p. 2071–78).

Im März 1839 trat er von Göttingen aus seine grosse Forschungsreise nach der Türkei an.

Diese Reise gab zu folgenden Publikationen Anlass:

17. Reise von Salonichi nach Vodena (in: *Cotta*'sches Ausland 1840).
18. Einige Bemerkungen über türkische Bäder. Hannover 1840. Gedruckt bei *G. Beese & Comp.* (12 pp. Separatdruck aus: *Holscher*. Hannover'sche Annalen der gesammten Heilkunde, V).
19. Reise durch Rumelien und nach Brussa im Jahre 1839. Erster Band Göttingen, *Vandenhoeck & Ruprecht*, 1841 (VI u. 362 pp.) Zweiter Band ib. 1841 (374 pp. u. 2 Tafeln).
20. Spicilegium Florae rumelicae et bithynicae exhibens synopsin plantarum quas aest. 1839 legit auctor *A. Grisebach*, Dr. med. Professor extr. Gottingensis. Vol. I. Brunsvigae, *Vieweg*, 1843. (XII u. 407 pp.). Vol. II. ib. 1844. (548 pp.). [Vol. 1, pp. 1–160, Feb. or Mar. 1843 (before Apr. 1843 according to Grisebach in vol. 2, p. 497, no. 114), pp. 161–407, Dec. 1843; vol. 2, pp. 1–160, probably June 1844, pp. 161–548, Dec. 1845; cf. I. M. Johnston in Jour. Arnold Arb. **34:** 264. 1953].

Seit 1840 lieferte *Grisebach* 14 Jahre hindurch regelmässige Berichte über die Leistungen in der Pflanzengeographie und systematischen Botanik.

Hiervon sind erschienen:

21. Bericht über die Leistungen in der Pflanzengeographie während des Jahres 1840 (*Wiegmann's* Arch. für Naturgeschichte VII [2: 1841], p. 433–474).
22. Bericht über die Forschungen in der Pflanzengeographie während des Jahres 1841 (ibid. VIII [2: 1842], p. 406–462).
23. Bericht über die Leistungen in der Pflanzengeographie während des Jahres 1842 (ib. IX [2: 1843], p. 373–432). [English translation in Ray Society, Reports and Papers on Botany, 57–122. 1846]
24. Bericht über die Leistungen in der Pflanzengeographie während des Jahres 1843 (ib. X [2: 1844], p. 366–443). [English translation in Ray Society, Reports and Papers on Botany, 125–212. 1846]
25. Bericht über die Leistungen in der Pflanzengeographie während des Jahres 1844 (ib. XI [2: 1845], p. 329–416). [English translation in Ray Society, Reports and Papers on Botany, 312–413. 1849]
26. Bericht über die Leistungen in der Pflanzengeographie und systematischen Botanik während des Jahres 1845 (ib. XII [2: 1846], p. 317–394). [English translation in Ray Society, Reports and Papers on Botany, 417–493. 1849]

27. Bericht über die Leistungen in der systematischen Botanik während des Jahres 1846 [ib. XIV. 2 (1848) 169–194]
28. Bericht über die Leistungen in der Pflanzengeographie während des Jahres 1846 (ib. XIII [2: 1847], p. 409–472).
29. Bericht über die Leistungen in der geographischen und systematischen Botanik während des Jahres 1847 (ib. XIV [2: 1848], p. 257–350).
30. Bericht über die Leistungen in der geographischen und systematischen Botanik während des Jahres 1848 (ib. XV [2: 1849], p. 340–446).
31. Bericht über die Leistungen in der geographischen und systematischen Botanik während des Jahres 1849. [ib. XVI. 2 (1850) 251–350]
32. Bericht über die Leistungen in der geographischen und systematischen Botanik während des Jahres 1850 [ib. XVII. 2 (1851) 273–392]
33. Bericht über die Leistungen in der geographischen und systematischen Botanik während des Jahres 1851 [ib. XVIII. 2 (1852) 308–429]
34. Bericht über die Leistungen in der geographischen und systematischen Botanik während des Jahres 1852 [ib. XIX. 2 (1853) 287–411]
35. Bericht über die Leistungen in der geographischen und systematischen Botanik während des Jahres 1853 [ib. XXI. 2 (1855) 313–410]

In das Jahr 1840 fallen ferner noch:

36. *Edm. Boissier*, Voyage botanique dans le midi de l'Espagne. Livr. I u. II Paris 1839. (Rec. in: Götting. Gel. Anzeigen vom 17. Februar 1840 p. 281–286).
37. Proceedings of the Botanical Society of London. July 1836–Nov. 1839. London 1839 (Recension ibid. 19. März 1840 p. 462–464).
38. *E. Meyer*, Preussens Pflanzengattungen. Königsberg 1839 (Recension ibid. 14. Mai 1840 p. 779–781).
39. Transactions of the Linnean Society. Vol. XVII u. XVIII. London 1837–38. (Recension ib. 21. Mai 1840 p. 812–824).
40. Nova acta physico-medica Academiae Caesareae Leopoldino-Carolinae naturae Curiosorum. Tom. XI. Breslau 1839 (Recens. ibid. 27. und 29. Aug. 1840 p. 1369–91).
41. *E. Meyer*, Commentarii. (Recens. ibid.).

1841:

42. Verhandelingen over de natuurlijke geschiedenis der Nederlandsche overzeesche bezittingen door de leden der natuurkundige commissie in Oost-indië. Aflev. 1–3. Leyden 1839–40. (Recens. in Gött. Gel. Anz. vom 10. Juli 1841 p. 1071–1078).

1842 unternahm er eine neue botanische Forschungsreise nach Norwegen, als deren Ergebniss später veröffentlicht wurde:

43. Über den Vegetationscharacter von Hardanger in Bergens Stift. (*Wiegmann's* Archiv für Naturgeschichte, X. [Jahrgang 1844] p. 1–28). [Reprinted in item 139, pp. 30–51]

1842 erschienen:

44. *Royle*, Illustrations of the Botany and other branches of the natural history of the Himalayan mountains and of the flora of Cashmere. London 1833–40. (Recension in: Göttinger Gel. Anz. vom 5. Febr. 1842 p. 205–214).
45. *Bertolonii* Flora italica. Bologna 1833–39. (Recension — anonym — ibid. 26. Februar 1842 p. 329–332).

46. *Moris*, Flora sardoa. Turin 1837. (Recension — anonym — ibid. p. 332–334).
47. *Edm. Boissier*, Voyage botanique dans le midi de l'Espagne. Livr. III–XVII. Paris 1839–41. (Recension — anonym — ibid. 14. u. 16. April 1842 p. 598–613).
48. Smilaceae et Dioscoreae. Exposuit *Aug. Henr. Rud. Grisebach*, (in: *de Martius*, Flora Brasiliensis, fasc. III–V. Vindob. et Lipsiae 1842 1. Aprilis p. 1–48, c. tab. 1–6).

1843:

49. Gentianeae, (in: Nova Acta Academ. Caesar. Leop. Carolinae vol. XIX [1843] supplem. p. 47–52).
50. Beobachtungen über das Wachsthum der Vegetationsorgane in Bezug auf Systematik.
Erster Abschnitt (*Wiegmann's* Archiv IX [1843] p. 267–292).
Zweiter Abschnitt (ib. X p. 134–155 mit Tafel). Dazu: Nachtrag zu den Beobachtungen über das Wachsthum der Blätter. (ib. p. 345 bis 347 mit Tafel).
Dritter Abschnitt (ib. XII p. 1–33).
51. *F. Unger*, die Pflanze im Momente der Thierwerdung. Wien 1843. (Recension in: Göttinger Gel. Anzeigen vom 21. October 1843 p. 1675 bis 1676).

1844:

52. *Ch. Gaudichaud*, recherches générales sur l'organographie. la physiologie et l'organogénie des végétaux. Paris 1841 (Recens. ib. 27. Juni 1844 p. 1014–22).
53. Sir *W. J. Hooker*, Icones plantarum vol. II–VI. London 1840–43. (Recens. ib. 7. September 1844 p. 1427–39).
54. *Meyen's* Reliquiae (Recension ibid.).
55. Phytozoen an Phanerogamen. (Botanische Zeitung. II p. 661). [English translation in Ann. Mag. Nat. Hist. **15:** 264–265. 1845 "On the occurrence of phytozoa in phanerogamous plants"]

1845:

56. a. *Kirschleger*, Notice sur la végétation comparée du Jura. des Vosges et de la Forêt Noire.
b. id., Statistique végétale de Strassbourg.
c. *K. Schimper*, über den Bau der Cruciferenblüthe.
d. *M. Rameaux*, des températures végétales.
In: Congrès scientifique de France. Strassbourg 1843. (Recension in: Göttinger Gel. Anzeigen vom 1. März 1845 p. 338–341).
57. *J. Bennet* und *Rob. Brown*, Plantae javanicae. Part 1–3. London 1838–44. (Recension ib. 28. April u. 1 Mai 1845. p. 682–693).
58. *Goeppert* und *Berendt*, die im Bernstein befindlichen organischen Reste der Vorwelt. Berlin 1845 (Recension ib. 6. und 8. November 1845. p. 1770–89).
59. Über die Pflanzenernährung (*Poggendorf's* Annalen LXIV p. 630–32).
60. Gentianaceae (in: *De Candolle*. Prodromus systematis naturalis. Vol. IX. [pp. 38–141, 561–563] Paris 1845).
61. Über die Bildung des Torfs in den Emsmooren aus deren unveränderter Pflanzendecke (in: Göttinger Studien. redigirt von *A. B. Krische* Göttingen *Vandenhoeck & Ruprecht* 1845 p. 255–370). [Reprinted in item 139. pp. 52–135]

1846:

62. Novor. Actor. Academ. Caesar. Leopold. Carolinae tom. XX. u. XXI.

Breslau 1843. 45. (Recension in: Göttinger Gel. Anzeigen vom 9. u. 12. Februar 1846, p. 233–243).

63. Über die Bildung des Torfs. (Selbstanzeige, ibid. 19. März 1846, p. 442–44).

1847:

64. Über die Vegetationslinien des nordwestlichen Deutschlands (in: Göttinger Studien. Göttingen *Vandenhoeck & Ruprecht* 1847 p. 461–562). [Reprinted in item 139, pp. 136–216]

1848:

65. Über die Vegetationslinien (Selbstanzeige in: Göttinger Gel. Anzeigen vom 19. October 1848 p. 1667–69).

66. *St. Endlicher*, Synopsis Coniferarum. St. Gallen 1847. (Recens. ibid. 8. Januar 1848 p. 41–52).

67. *C. Nägeli*, die neueren Algensysteme und Versuch eines eigenen Systems der Algen und Florideen. Zürich 1847. (Recension, ibid. 9. u. 11. März 1848 p. 395–416).

68. *v. Middendorff* und *v. Trautvetter*, Reise in den äussersten Norden und Osten Sibiriens. St. Petersburg 1847. (Recens. ibid. 16. Septbr. 1848 p. 1481–90).

69. Plantae Kegelianae Surinamenses. (in: Linnaea, XXI, p. 181–284).

1849:

70. Beiträge zu einer Flora der Äquinoctial-Gegenden der neuen Welt [Malpighiaceae, [Trigoniaceae], Gentianeae]. (Linnaea, XXII p. 1–46).

71. Plantae Regnellianae [Gentianeae] (ib. p. 567 f.).

Im Jahre 1850 unternahm *Grisebach* eine grössere wissenschaftliche Reise in die Pyrenäen, auf welcher u. a. die Hieracien besonders studirt wurden, deren Monographie er vorbereitete. Es erschien in diesem Jahre:

72. Ein neues deutsches Hieracium (Botanische Zeitung, VIII, p. 638).

73. *Irmisch*, zur Morphologie der monokotylischen Knollen- und Zwiebelgewächse. Berlin 1850. (Recens. in: Göttinger Gel. Anzeigen vom 27. März 1850 p. 481–93).

1851 machte er mit *A. Schenk* eine gemeinsame Forschungsreise in die Alpen, nämlich durch das westliche Tirol, das Engadin, die Lombardei, Piemont und Dauphiné, als deren Frucht veröffentlicht wurde:

74. Observationes quaedam de plantis, quas in itinere alpino a. 1851 suscepto legerunt *A. Grisebach* et *A. Schenk*. (Linnaea, XXV, 593–611).

Den Herbst des Jahres 1852 benutzte er zu einer botanischen Reise, wieder mit *Schenk*, in die Karpaten. Die Ergebnisse sind niedergelegt in

75. Iter hungaricum a. 1852 susceptum. Beiträge zur Systematik der ungarischen Flora. (*Wiegmann's* Archiv, XVIII p. 291–362).

1852 erschien ferner:

76. Commentatio de distributione Hieracii generis per Europam geographica. Auctore *A. Grisebach*. Sectio prior. Revisio specierum Hieracii in Europa sponte nascentium. Gottingae, Sumptibus Dieterichianis, MDCCCLII (4°. 80 pp. Separat-Abdruck aus dem V. Bande der Abhandlungen der königl. Gesellschaft der Wissenschaften zu Göttingen.)

77. Über die geographische Verbreitung der europäischen Hieracien. (Selbst-

anzeige in: Nachrichten von der königl. Gesellschaft der Wissenschaften. August 1852).

Später (1867 s. unten Nr. 113) bemerkte *Grisebach* über diese Schrift: "Meine in den Schriften der Göttinger Societät über die Hieracien veröffentlichte Abhandlung blieb unvollendet, weil die Hoffnung, ihre geographische Verbreitung aus äusseren Einflüssen ableiten zu können, nicht in Erfüllung ging."

78. Gramina Rossica. Exposuit *A. Grisebach*. (Seorsim impressa ex *Ledebour* Flor. Ross. Vol. IV) [pp. 324–464. 1852; 465–484. 1853] Stuttgartiae. Sumtibus librariae E. Schweizerbart. 1852. (163 pp.)
79. Über einige kritische Epilobien. (Botanische Zeitung [X] vom 3. December 1852 p. 849–55).

1853:

80. *Grisebach* und *Oersted*, Malpighiaceae centroamericanae. (Vidensk. Meddelelser fra den naturh. Forening i Kjöbenhavn for 1853 p. 43–52).
81. Gentianeae (ibid. 11 pp).
82. Schenkia, novum genus Gentianearum (Bonplandia, I, p. 226).
83. *Tiedemann*, Geschichte des Tabaks und anderer ähnlicher Genussmittel. Frankfurt a/M. 1854. (Recens. in: Göttinger Gel. Anzeigen vom 24. u. 27. October 1853 p. 1697–1708).
84. Sir *John Richardson*, Arctic searching expedition. London 1851. (Recens. ibid. 12. u. 15. December 1853 p. 1981–98).
85. *Seemann*, Narrative of the voyage of *H. M. S. Herald*. London 1853. (Recens. ibid. 15. u. 17. December 1853 p. 1998–2013).

1854:

86. *K. Koch*, Die Krim und Odessa. Leipzig 1854 (Recens. ib. 18. Dec. 1854 p. 2001–2005).
87. Grundriss der systematischen Botanik für akademische Vorlesungen entworfen von *A. Grisebach*. Göttingen, Verlag der Dieterich'schen Buchhandlung, 1854 (180 pp).
88. Systematische Bemerkungen über die beiden ersten Pflanzensammlungen *Philippi's* und *Lechler's* im südlichen Chile und an. der Maghellans-Strasse. Mit 1 Kupfertafel. Göttingen, in der Dieterich'schen Buchhandlung. 1854 (in 4°. 50 pp. Separat-Abdruck aus dem VI. Bande [Phys., pp. 89–138] der Abhandlungen der königl. Gesellschaft der Wissenschaften zu Göttingen).

1857:

89. Systematische Untersuchungen über die Vegetation der Karaiben, insbesondere der Insel Guadeloupe. Göttingen, Verlag der Dieterich'schen Buchhandlung 1857 (in: 4°. 138 pp. Separat-Abdruck aus dem VII. Bande [Phys., pp. 151–286] der Abhandlungen der königl. Gesellschaft der Wissenschaften zu Göttingen).

1858:

90. Novitiae Florae panamensis. (Bonplandia, VI, p. 2–12).
91. Malpighiaceae. Exposuit *Aug. Henr. Rud. Grisebach*. (in: *de Martius* Flora Brasiliensis, fasc. XXI. in folio p. 1–124 m. Taf. 1–22).

Das Material zu der letztverzeichneten Arbeit war ihm durch Herrn v. *Martius* im Jahre 1853 zugegangen. Am 10. Februar 1857 konnte er die betreffende Pflanzenkiste nach beendigter Untersuchung nach München zurücksenden.

In dem nämlichen Jahre (1857) liess ihm die königlich grossbritannische Regierung durch Sir *William Hooker* die Bearbeitung einer westindischen Flora antragen. Nach sechsjähriger Arbeit war das durchweg in englischer Sprache geschriebene Werk (am 13. Juli 1863) im Manuscript vollendet. Die Vorrede ist "Göttingen, 26th June, 1864" datirt. Viermal hatte er einen längeren Aufenthalt in London, behufs Benutzung der dortigen Museen, genommen. Das gesammte Werk führt den Titel:

92. Flora of the British West Indian Islands. London: Lovell Reeve & Co. Henrietta Street, Covent Garden. 1864. (XVI u. 789 pp). [pp. 1–96. (Dec.) 1859; pp. 97–192. (June) 1860; pp. 193–315. (end of Loranthaceae), late 1860; pp. 315–410. late 1861; pp. 411–506. 1862 (probably May); pp. 507–602, 603–789, i–xvi. (October) 1864]

Während der Arbeit an diesem grossen Werke erschienen als Parerga:

1859:

93. Notes on Abuta, a genus of Menispermeae. (Journ. Linn. Soc. botan. III p. 108).

1860:

94. Erläuterungen ausgewählter Pflanzen des tropischen Amerikas. Göttingen, Verlag der Dieterich'schen Buchhandlung. 1860 (in 4°, 58 pp. Separat-Abdruck aus dem IX. Bande [Phys., pp. 3–58] der königl. Gesellschaft der Wissenschaften zu Göttingen).
95. Plantae Wrightianae e Cuba orientali. Pars I. Cantabrigiae Nov. Angl. Dec. 1860 (in: 4°, ex Mem. Acad. Amer. Scient. et Artium, N. Ser. Tom. VIII p. 153–192).

1861:

96. Notice sur le genre Rheedia (Ann. des scienc. natur. botanique XV p. 231–235).
97. Bemerkungen zu *Wilkomm's* Monographie der europäischen Krummholzkiefern. (Flora [XLIV] vom 14. October 1861 p. 593–98).
98. Zur Systematik der Birken (ibid. [XLIV] 28. Oct. 1861 p. 625–31).

1862:

99. Plantae Wrightianae e Cuba orientali. Pars II. Cantabrigiae Nov. Angl. Nov. 1862 (in: 4°, ex Mem. Acad. Amer. VIII p. 503–36).
100. Notes on Coutoubea volubilis, Mart., and some other Gentianeae of tropical America. (Journ. Linn. Society [Bot.] VI p. 140–46).

1863:

101. Über einen wahrscheinlichen Dimorphismus bei den Farnen. (Nachrichten der königl. Gesellschaft der Wissenschaften zu Göttingen vom 25. März 1863 p. 101–12).
102. Das Pflanzenleben der Donauländer. Von *A. Kerner*. Innspruck 1863. (Recension in: Göttinger Gelehrte Anzeigen vom 28. October 1863, p. 1686–92). [Reprinted in item 139, pp. 217–221]
103. *Christ's* Übersicht der europäischen Abietineen. (Regensburger Flora [XLVI] 1863 p. 189–90).

1864:

104. Über die von *Fendler* in Venezuela gesammelten Bromeliaceen. (Nach-

richten von der königl. Gesellschaft der Wissenschaften zu Göttingen. vom 13. Januar 1864 p. 1–21).

105. On Welwitschia, a new genus of Gnetaceae by *Jos. Dalt. Hooker*. London 1863 (Bericht in: Göttinger Gelehrte Anzeigen vom 27 Januar 1864 p. 127–47).

1865:

106. Die geographische Verbreitung der Pflanzen Westindiens. Göttingen. in der Dieterich'schen Buchhandlung 1865 (in 4°. 80 pp.: Separat-Abdruck aus dem XII. Bande [Phys., pp. 3–80] der Abhandlungen der königl. Gesellschaft der Wissenschaften zu Göttingen). [Reprinted in item 139, pp. 222–285]

107. Flora of the British West Indian Islands by *A. H. R. Grisebach* London 1864 (Selbstanzeige, zugleich Anzeige von Nr. 106 in: Göttinger Gelehrte Anzeigen vom 1. März 1865 p. 321–330).

108. Diagnosen neuer Euphorbiaceen aus Cuba. (Nachrichten von der königl. Gesellschaft der Wissenschaften vom 15. März 1865 p. 161–81).

1866:

109. Catalogus plantarum Cubensium exhibens collectionem Wrightianam aliasque minores ex insula Cuba missas. Lipsiae apud Guilielmum Engelmann 1866 (IV. u. 301 pp.).

110. Die Vegetationsgebiete der Erde, übersichtlich zusammengestellt. Mit Karte (*Petermann's* geogr. Mittheilungen 1866 II, p. 45–53).

111. Der gegenwärtige Standpunkt der Geographie der Pflanzen. (*Behm's* geogr. Jahrbuch I, p. 373–402). [Reprinted in item 139, pp. 307–334]

1867:

112. Catalogus plantarum Cubensium quas recensuit *A. Grisebach*. Lipsiae 1866. (Selbstanzeige in: Göttinger Gelehrte Anzeigen. Stück 12. 1867 p. 465–67).

113. Botanische Mittheilungen von *C. Nägeli*. München 1866. (Bericht ibid. Stück 18 p. 696–712).

1868:

114. Über die Gramineen Hochasiens. (Nachrichten von der königl. Gesellschaft der Wissenschaften zu Göttingen vom 12. Februar 1868. p. 61–93). [Reprinted in item 139, pp. 286–306]

115. Bericht über die Fortschritte in der Geographie der Pflanzen. (*Behm's* geogr. Jahrbuch II, p. 186–219). [Reprinted in item 139, pp. 334–366]

1870:

116. Bericht über die Fortschritte in der Geographie der Pflanzen (ibid. III, p. 172–210). [Reprinted in item 139, pp. 367–402]

Im Jahre 1872 erschien das 1866/67 begonnene, den Abschluss der pflanzengeographischen Studien des Verfassers bezeichnende Werk:

117. Die Vegetation der Erde nach ihrer klimatischen Anordung. Ein Abriss der vergleichenden Geographie der Pflanzen. Erster Band. Leipzig. Verlag von Wilhelm Engelmann 1872 (XII u. 603 pp.). Zweiter Band. Mit einer Übersichtskarte der Vegetationsgebiete. Ibid. 1872. (X u. 635 pp. und Sach- und Personen-Register p. 637–709).

Seit seinen langjährigen Jahresberichten (cf. oben Nr. 21–35), welche, soweit

sie von bleibendem Gehalt, in die "Vegetation der Erde" eingearbeitet worden sind, hatte *Grisebach* das schon in seiner ersten Abhandlung (cf. oben Nr. 8) betretene Gebiet der Pflanzengeographie nie aus den Augen verloren, ja die systematischen Forschungen nur als die Grundlegung zu einer Erklärung des Phänomens der nach Floren gegliederten Pflanzendecke des Erdballs betrachtet.

Von der "Vegetation der Erde" erschien alsbald eine russische Übersetzung von *Beketoff* (s. oben p. 511), sowie eine französische, welche betitelt ist:

La végétation du Globe d'après sa disposition suivant les Climats. Esquisse d'une géographie comparée des plantes. Par *A. Grisebach*. Ouvrage traduit de l'allemand avec l'autorisation et le concours de l'Auteur par *P. de Tchihatchef* Correspondant de l'Institut de France. Avec des annotations du Traducteur. Accompagné d'une carte générale des domaines de végétation. Tome premier. Paris *L. Guérin et Cie.* [später *J. B. Baillière et Fils*] 1875 (gr. 8°, XVI u. 765 pp.). Tome deuxième. Paris, librairie *J. B. Baillière et Fils* 1878 (VI u. 905 pp.).

Grisebach schrieb eine neue Vorrede dazu (October 1874 t. I p. XIV–XVI) und hat das Manuscript des Übersetzers vor dem Drucke einer sorgfältigen Durchsicht unterworfen. [A posthumous second edition, "Zweite, vermehrte und berichtigte Auflage" Erster Band 1884 (xv + 567 pp.) Zweiter Band 1884 (xi + 594 pp.) Register 1885 (pp. 597–693)]

In das Jahr 1872 fallen ferner noch:

118. Die Wirksamkeit *Humboldt's* im Gebiete der Pflanzengeographie und Botanik. (*A. v. Humboldt*, eine wissenschaftliche Biographie, herausgegeben von *Bruhns*. Leipzig, F. A. Brockhaus 1872. Band III p. 232–268). [Reprinted in item 139, pp. 557–584]

119. Bericht über die Fortschritte in der Geographie der Pflanzen. (*Behm's* Geogr. Jahrbuch IV, p. 21–58). [Reprinted in item 139, pp. 403–438]

120. *V. Hehn*, Kulturpflanzen und Hausthiere in ihrem Übergange aus Asien nach Griechenland und Italien, sowie in das übrige Europa. Berlin 1870. (Recension in: Göttinger Gelehrte Anzeigen vom 6. November 1872 p. 1766–77).

121. *Blumenbach*. Von *A. Grisebach*. (in: Göttinger Professoren. Ein Beitrag zur deutschen Kultur- und Literärgeschichte. Gotha 1872, p. 139–165).

1873:

122. *A. S. Oersted's* System der Pilze, Lichenen und Algen. Aus dem Dänischen. Deutsche vermehrte Ausgabe von *A. Grisebach* und *J. Reinke*. Mit 93 Figuren in Holzschnitt. Leipzig, Verlag von Wilhelm Engelmann, 1873. (VI u. 194 pp.).

Die Übersetzung rührt ausschliesslich von *Grisebach* her, ebenso die Vorrede, die in Klammern dem Texte eingefügten Ergänzungen grösstentheils von Professor *Reinke* in Göttingen.

1874:

123. Plantae Lorentzianae. Bearbeitung der ersten und zweiten Sammlung argentinischer Pflanzen des Professor *Lorentz* zu Cordoba. Göttingen, in der Dieterich'schen Buchhandlung 1874, (in 4°, 232 pp. Mit 1 Tafel, Separat-Abdruck aus dem XIX. Bande [Phys., pp. 49–278] der Abhandlungen der königl. Gesellschaft der Wissenschaften zu Göttingen).

Der systematische Theil des Werkes ist in lateinischer Sprache verfasst

(p. 20 bis 232), voran geht eine Einleitung in deutscher Sprache, enthaltend: von p. 1–10 die pflanzengeographischen Ergebnisse (vgl. oben im Text p. 550–552) und von p. 10 unten bis p. 20 "systematische und morphologische Bemerkungen."

[Published December 1874 according to Croizat in Darwiniana **5**: 422, note 1, 1941]

124. Bericht über diese Publikation in: Nachrichten der königl. Gesellschaft der Wissenschaften 1874 p. 53 f.

125. Bericht über die Fortschritte in der Geographie der Pflanzen (*Behms* Geogr. Jahrbuch V, p. 46–97). [Reprinted in item 139, pp. 438–487]

1875:

126. Symbolae ad floram Brasiliae centralis cognoscendam edit. *Eug. Warming* Part. XXI:

Malpighiaceae, Dioscoraceae, Smilaceae. Exposuit Dr. *A. Grisebach*. (ex actis Videnskabelige Meddelelser societatis historico-naturalis Havniensis 1875 p. 121–164).

127. Pflanzengeographie, von *A. Grisebach* (in: Anleitung zu wissenschaftlichen Beobachtungen auf Reisen, herausgeg. von Dr. *G. Neumayer*, Berlin 1875, p. 333–358).

1876:

128. Bericht über die Fortschritte in der Geographie der Pflanzen (*Behms* Geogr. Jahrbuch, VI, p. 211–284). [Reprinted in item 139, pp. 487–556]

129. Bericht über die botanischen Institute der Universität Göttingen im Jahre 1876. Nachrichten d. Gesellschaft der Wissenschaften p. 58–64.

130. Index Seminum Horti Academici Gottingensis. 1876. Appendix: Species criticae quae a. 1876 in Horto Gottingensi floruerunt. Gottingae, typ. off. acad. Dieterich. (in folio. 8 pp.).

1877:

131. China. Ergebnisse eigener Reisen und darauf gegründeter Studien von *Ferd.* Freiherrn *v. Richthofen*, Berlin 1877. (Bericht darüber in Gött. Gelehrte Anzeigen vom 11. Juli 1877 p. 865–88). [Reprinted in item 139, pp. 585–602]

132. Über *Weddell's* Pflanzengruppe der Hypseocharideen. (in: Nachrichten der Gesellschaft der Wissenschaften 15. Aug. 1877 p. 493–500).

133. Zum Andenken an *Karl Ernst von Baer*, (ibid. 5. Dec. 1877 p. 745 bis 748). [Reprinted in item 139, pp. 600–602]

134. Index seminum. 1877. Appendix: Species novae vel criticae quae a. 1877 in Horto Gottingensi floruerunt. Gottingae, typ. off. acad. Dieterich. (in folio, 8 pp.).

1878:

135. Die systematische Stellung von Sclerophylax und Cortesia. (Nachrichten vom 15. Mai 1878 p. 221–28).

136. Der Dimorphismus der Fortpflanzungsorgane von Cardamine chenopodifolia Pers. Ein Beitrag zur Theorie der Befruchtung. Von *A. Grisebach*. (ibid. 12. Juni 1878 p. 332–341).

137. Index seminum, 1878. Appendix: Species novae vel criticae, quae a. 1878 in Horto Gottingensi floruerunt. Gottingae, typ. off. acad. Dieterich. (in folio, 8 pp).

1879:

138. Symbolae ad Floram argentinam. Zweite Bearbeitung argentinischer Pflanzen, nach den durch die Regierung zu Buenos-Ayres veranstalteten Sammlungen der Professoren *Lorentz* und *Hieronymus*, sowie den im Museum zu Göttingen aufbewahrten Herbarien anderer Naturforscher. Von *A. Grisebach*. Göttingen, Dieterich'sche Verlagsbuchhandlung, 1879 (in 4°, 346 pp. aus dem XXIV. Bande [Phys., pp. 3–346] der Abhandlungen der königl. Gesellschaft der Wissenschaften zu Göttingen).

Über das Werk meldete er seinem ältesten Sohne am 13. December 1878: "Meine Symbolae ad Floram argentinam werden nun seit Anfang November gedruckt, bereits 13 Bogen — es werden über 40, so dass ich mich nun zu andern botanischen Arbeiten wenden kann." Diese neue Arbeit war zunächst eine Flora europaea, von welcher er im Winter 1878/79 die Familien der Ranunculaceen, Berberideen, Nymphaeaceen, Papaveraceen und einen Theil der Cruciferen vollendete. Jede Art ist mit einer kurzen lateinischen Diagnose begleitet, die geographische Verbreitung ist in deutscher Sprache angegeben. Bei Sisymbrium contortuplicatum DC. bricht das 68 Quartseiten engster Schrift umfassende Manuscript jäh ab.

[139. Gesammelte Abhandlungen und kleinere Schriften zur Pflanzengeographie von A. Grisebach. Leipzig, verlag von Wilhelm Engelmann. 1880 (vii + 628 pp.)]

[140. Reliquiae Grisebachianae. Flora Europaea. Fragmentum auctore Augusto Grisebach ex Manuscripto . . . edidit Augustus Kanitz. Claudiopoli, apud E. Demjén 1882 (58 pp.).
This is the concise synopsis of the European flora on which Grisebach was working shortly before his death; see under item 138 above.]

SCOPE OF GRISEBACH'S FLORA

Although long out of date in much of its nomenclature and taxonomy, often unreliable in matters of detail and concerned only with the British West Indian Islands, which occupied only about an eighth of the total land area of the West Indies and by 1864 had been far from exhaustively explored botanically, Grisebach's *Flora* remains nevertheless the most comprehensive general descriptive guide to the plants of the archipelago stretching from the Bahamas and the Florida Keys to Trinidad and Aruba.

Floristically these islands may be divided into five main groups, those covered by Grisebach's book being cited in LARGE and SMALL CAPITALS:

1. The **Bahamas,** i.e. the BAHAMA ISLANDS comprising 29 major islands and about 3,000 islets (in all 4,403 sq. miles) [4] and the Turks and Caicos Islands (170 sq. miles.)

2. The **Greater Antilles,** consisting of Cuba (44,178 sq. miles), Hispaniola (29,838 sq. miles), JAMAICA (4,411 sq. miles), Cayman Islands (100 sq. miles), Puerto Rico (3,450 sq. miles) and the Virgin Islands (67 sq. miles), and separated by the deep Anegada Passage from the Lesser Antilles proper.

[4] 1 square mile = 2.59 square kilometers.

FIG. 2. THE WEST INDIAN ISLANDS. Roman numerals refer to "the five natural sections" noted by Grisebach (for discussion of this division see page vi of Grisebach's text). The islands considered by Grisebach are in solid black.

3. The **Lesser Antilles:**

(a) Leeward Islands, between the Anegada Passage and the Martinique Passage, including Anguilla (35 sq. miles), St. Martin (38 sq. miles), St. Barthélemy (8 sq. miles), Saba (5 sq. miles), St. Eustatius (9 sq. miles), ST. KITTS (68 sq. miles), NEVIS (50 sq. miles), BARBUDA (62 sq. miles), ANTIGUA (108 sq. miles), MONTSERRAT (32 sq. miles), Guadeloupe (Grande Terre, 255 sq. miles; Basse Terre, 364 sq. miles), Marie Galante (60 sq. miles), DOMINICA (305 sq. miles); the Virgin Islands are usually listed under the Leeward Islands.

(b) Windward Islands, from the Martinique Passage south to Grenada, including Martinique (430 sq. miles), ST. LUCIA (238 sq. miles), ST. VINCENT (150 sq. miles), Bequia (7 sq. miles) The Grenadines (13 sq. miles), GRENADA (133 sq. miles).

(c) BARBADOS (166 sq. miles).

Alternatively

(a) Eastern Arc: Anguilla, St. Martin, St. Barthélemy, BARBUDA, ANTIGUA, Guadeloupe (Grande Terre), Désirade, Marie Galante; these form a series of old limestone-topped volcanic islands.

(b) Western Arc: Saba, St. Eustatius, ST. KITTS, NEVIS, MONTSERRAT, Guadeloupe (Basse Terre), DOMINICA, Martinique, ST. LUCIA, ST. VINCENT, Bequia, The Grenadines, GRENADA; these form a series of younger volcanic islands.

(c) BARBADOS.

4. **Tobago** (116 sq. miles) and **Trinidad** (1,864 sq. miles).

5. **Southern Caribees,** consisting of Aruba (67 sq. miles), Curaçao (164 sq. miles), Bonaire (93 sq. miles), etc.

Trinidad belongs geologically and floristically not to the West Indies but to northern South America, as Grisebach pointed out as long ago as 1865: "schon jetzt ist man indessen berechtigt, Trinidad von Westindien nach seiner Pflanzenproduktion zu trennen und als ein Glied des Festlandes zu betrachten." The Lesser Antilles are similarly independent of the Greater Antilles. An observation by Alston (1952) emphasizes this: "the 80 miles of sea separating Tobago from Grenada, and the 120 miles which separate St. Thomas from Saba are more formidable barriers to *Selaginella* than the 90 miles between Cuba and Jamaica, and there seems to be no reason for this but the geological history of the various islands" (Bull. Brit. Mus. (Nat. Hist.), Bot. 1: 28). Barbados and Tobago are on the same South American continental shelf and thus not geologically associated with the volcanic Lesser Antilles. As a result of covering such a heterogeneous assembly of islands Grisebach's *Flora* includes most of the widespread tropical lowland weeds, together with many endemic West Indies species and a number of characteristic South American species.

According to an analysis by Krug in Urban, *Symb. Ant.* 1: 57. 1898, Grisebach recorded from the individual islands the following number of

species of vascular plants (to which some more recent estimates or counts are added in parentheses for comparison):

BAHAMAS 191 (995 phanerogams, 69 pteridophytes, fide Britton & Millspaugh, 1920).
JAMAICA 2303 (approx. 2900 phanerogams, 540 pteridophytes).
ST. KITTS 129 (no total for phanerogams available; 129 pteridophytes).
NEVIS 11 (no total for phanerogams available; 83 pteridophytes).
BARBUDA 1 (230 phanerogams; no record of pteridophytes).
ANTIGUA 520 (approx. 724 phanerogams, 34 pteridophytes).
MONTSERRAT 48 (no total for phanerogams available, 68 pteridophytes).
DOMINICA 684 (no total for phanerogams available, 191 pteridophytes).
ST. LUCIA 82 (no total for phanerogams available, approx. 120 pteridophytes).
BARBADOS 63 (approx. 830 phanerogams, 22(+) pteridophytes).
ST. VINCENT 635 (approx. 1000 phanerogams, 160 pteridophytes).
GRENADA 16 (no total for phanerogams available, approx. 90 pteridophytes).
TOBAGO 4 (no total for phanerogams available, 95 pteridophytes).
TRINIDAD 1,282 (approx. 2,200 phanerogams, 300 pteridophytes).

This gives a total of 3,143 phanerogams, 356 pteridophytes. Grisebach's *Flora* thus deals with about a third of the phanerogam species and about half of the pteridophyte species known from the West Indian archipelago between Florida and Venezuela.

PUBLICATION OF GRISEBACH'S FLORA

The *Flora of the British West Indian Islands* was published in London in seven parts as follows:

PART	DATE	COMMENTS AND SOURCES
Part 1, pp. 1–96	December, 1859	Received by Linnean Society on 14 Dec. 1859, by British Museum on 20 Dec. 1859. Cf. Grisebach in Abh. Kön. Ges. Wiss. Göttingen (Phys.) **9**: 16. 1861.
Part 2, pp. 97–192	June, 1860	Received by L. S. and B. M. on 4 June 1860.
Part 3, pp. 193–315 (ending with Loranthaceae), 316 (blank), 317–322 (index to Section I), half-title and title to Section I; this p. 315, dealing with Loranthaceae but not Caprifoliaceae, and the index to Section I have been discarded as redundant in most bound copies.	late 1860	Received by L. S. on 2 Nov. 1860, by B. M. on 3 Dec. 1860. Cf. Am. Jour. Sci. II. **31**: 129. (Jan.) 1861.

Part 4, pp. 315–410	late 1861	Received by L. S. on 2 Nov. 1861, by B. M. on 6 Dec. 1861. "Im Druck vollendet" on 25 Sept. 1861 fide Grisebach in Bot. Zeit. **19**: 296. (Oct.) 1861.
Part 5, pp. 411–506	1862 probably May	Received by L. S. on 14 May 1862.
Part 6, pp. 507–602))) Part 7, pp. 603–789, i–xvi)	October 1864	Received by L. S. on 1 Oct. 1864, by B. M. on 8 Oct. 1864. Cited in Gard. Chron. **1864**: 1038. (29 Oct.) 1864, Jour. Bot. (London) **2**: 360. (1 Nov.) 1864, Am. Jour. Sci. II. **39**: 108. (Jan.) 1865.

The details cited above correct the account of publication by B. D. Jackson in *Jour. Bot.* (London) **30**: 347. 1892, and accepted by Urban, *Symbolae Antillanae* **1**: 57. 1898.

BIOGRAPHICAL NOTES ON COLLECTORS

Grisebach based his *Flora* chiefly on herbarium material assembled at the Royal Botanic Gardens, Kew, through the enterprise of William Jackson Hooker. This material included many specimens collected by residents, mostly medical men, in the British West Indies, notably Bancroft, Crueger, Distin, Finlay, Guilding, Imray, Lane, Lockhart, Macfadyen, Gilbert McNab, March, Nicholson, Schack, Robert Schomburgk, Waters, Wiles, and Wilson. For Jamaica the most interesting and extensive collections studied were those made by Purdie, sent out from Kew in 1843, and by Alexander (later Prior), who visited Jamaica in 1849–50. Grisebach came to England four times during the preparation of the work and was able to have much material from Kew on loan at Göttingen and to retain fragments for his private herbarium, which remains at Göttingen. He also had available the collections, not represented in British herbaria, made by Wullschlägel and Bertero. The historic collections by Sloane, Masson, Roger Shakespear, Swartz, and others, then at the British Museum, Bloomsbury, now at the British Museum (Natural History), South Kensington, London, were known to Grisebach but he made little use of them, probably because they were then less accessible than the later collections at Kew.

The following notes on collectors cited by Grisebach are based on Urban's "Notae biographicae peregrinatorum Indiae occidentalis botanicorum" in *Symbolae Antillanae* **3**: 14–158. 1902, but provide some information not available to Urban.

ALEXANDER (after 1859 PRIOR),[5] RICHARD CHANDLER (1809–1902);

[5] The names of some collectors cited in his *Flora* were abbreviated by Grisebach as

English medical man; author of *Popular Names of British Plants* (1863), etc.; collected from November 1849 to August 1850 in Jamaica, mostly in the Blue Mountains and St. Ann (with Moneague as center); adopted the name of Prior after the death of maternal uncle so-named, thereafter spent six months of every year on his property at Halse near Taunton, Somerset, England, the other six months in London; herbarium at Kew; Urban, *Symb. Ant.* 3: 107. 1902; Proc. Linn. Soc. London sess. 115 (1902–03): 35. 1903.

ANDERSON, ALEXANDER (d. 1811); medical man; settled in St. Vincent between 1775 and 1785, being from 1785 to 1811 superintendent of the St. Vincent Botanic Garden; visited Guiana in 1791; Guiana plants in British Museum (Nat. Hist.), West Indian plants at Kew; Urban, *Symb. Ant.* 3: 17. 1902.

BANCROFT, EDWARD NATHANIEL (1772–1842); English medical man; settled in Jamaica in 1811 and died there in 1842 as General Inspector of the Army Hospital at Kingston; herbarium at Kew; Urban, *Symb. Ant.* 3: 19. 1902.

BERTERO, CARLO GIUSEPPE (1789–1831); Italian medical man; studied medicine and natural history in Turin under Balbis; travelled to West Indies in 1816 as a ship's surgeon; was 1816–18 in Guadeloupe, 1818 in St. Thomas, 1818–19 in Puerto Rico, 1819–20 in Santo Domingo and Haiti, 1820–21 in Colombia, 1821 in Jamaica which he visited on his way back to Europe; in 1827 went to Chile, thence in 1830 to Tahiti; on the return to Valparaiso from Tahiti his ship was lost at sea without a trace; main herbarium at Turin, much material at Geneva, other specimens at Paris, Munich, etc.; Urban, *Symb. Ant.* 3: 21, 22. 1902.

BRADFORD, DR.; collected orchids in Trinidad, 1845–46, Antigua, 1846; specimens at Kew; Urban, *Symb. Ant.* 3: 27. 1902.

BROWNE, PATRICK (ca. 1720–90); Irish medical man; studied at Leyden; voyaged about 1745 to Barbados, Montserrat, Antigua, and St. Kitts, settling in Jamaica in 1746, where he journeyed and collected extensively; returned to England in 1755, where he published in 1756 his *Civil and Natural History of Jamaica* (the original edition being 250 copies, fide Sabin, *Dict. Books* 2: 572. 1869, quoting Chalmers); went back to the West Indies but returned to England in 1781, and then retired to County Mayo, Ireland, his birthplace; in 1758 Linnaeus bought his herbarium, now part of Linnaean Herbarium at the Linnean Society of London; some specimens in British Museum (Nat. Hist.); Urban, *Symb. Ant.* 3: 29. 1902; Stearn, *Introd. Sp. Pl.* 76. 1957.

CRUEGER, HERMANN (1818–64); German apothecary from Hamburg, who settled in Trinidad in 1841; appointed on Purdie's death, in 1857, as

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indicated here: Alexander (*Al.*), Anderson (*Anders.*), Bancroft (*Bancr.*), Crueger (*Cr.*), Distin (*Dist.*), Elsey (*Els.*), Guilding (*Guild.*), Hartweg (*Hartw.*), Hjalmarsson (*Hjalmars.*), Imray (*Imr.*), Lockhart (*Lockh.*), Macfadyen (*Macf.*), McNab (*M'Nb.*), Oersted (*Oerst.*), Purdie (*Pd.*), Schack (*Sch.*), Sieber (*Sieb.*), Swainson (*Swains.*), Swartz (*Sw.*), Wilson (*Wils.*), Wullschlägel (*Wullschl.*).

government botanist and director of the botanic garden at Port-of-Spain, Trinidad; specimens at Kew; Urban, *Symb. Ant.* 3: 33. 1902.

DISTIN, HENRY (d. ca. 1840); medical man; lived at Savanna-la-Mar, Jamaica, whence he sent specimens to W. J. Hooker in 1831, 1833, and 1836; his medical work prevented him from collecting except near Savanna-la-Mar; specimens at Kew; Urban, *Symb. Ant.* 3: 37. 1902.

DON, GEORGE, the younger (1798–1856); Scottish gardener and botanist, son of GEORGE DON the elder (1764–1814), and brother of DAVID DON (1799–1841); in 1822–23 collected for the Horticultural Society of London in Brazil, Cuba, Jamaica, and Sierra Leone on the voyage of the *Iphigenia*; some specimens in British Museum (Nat. Hist.); Urban, *Symb. Ant.* 3: 38. 1902.

ELSEY, JOSEPH RAVENSCROFT (1834–57); English medical man and naturalist; went in 1857 to the West Indies to collect specimens for Grisebach's *Flora* but died after only seven weeks on the island of St. Kitts; specimens at Kew; Urban, *Symb. Ant.* 3: 44. 1902.

FENDLER, AUGUST (1813–83); German plant-collector; emigrated in 1836 to the United States; in 1846–47 collected botanical specimens in New Mexico, in 1850 in Panama, in 1854–58 in Venezuela, in 1877–83 in Trinidad, where he died. W. M. Canby, "An autobiography and some reminiscences of the late August Fendler," Bot. Gaz. 9: 285–290, 301–304, 319–322. 1884; Urban, *Symb. Ant.* 3: 47. 1902.

FINLAY, KIRKMAN (d. ca. 1884); medical man; settled in Trinidad ca. 1837 and collected there as well as in Antigua, Grenada, and Dominica; specimens at Kew; Urban, *Symb. Ant.* 3: 47. 1902.

FRASER, JOHN (1750–1811); Scottish plant-collector and nurseryman; made journeys in 1780, 1784–85, 1790, 1791, and 1795 to North America; in 1801 visited Cuba, in 1802 New Providence, Bahamas; Urban, *Symb. Ant.* 3: 48. 1902.

GUILDING, LANSDOWN (ca. 1797–1831); clergyman; born on St. Vincent; studied at Oxford; returned to St. Vincent in 1817; specimens at Kew; Urban, *Symb. Ant.* 3: 53. 1902.

HARTWEG, CARL THEODOR (1812–1871); German gardener and plant-collector; went, in 1836, to Mexico for the Horticultural Society of London, also visited Guatemala, Peru, Ecuador, and Colombia and on return journey stopped in Jamaica during May 1843, collecting in the Port Royal Mountains, north of Kingston, in company with Purdie, before going on to England; (cf. Bentham, *Pl. Hartweg.* 263–266. 1846); specimens at Kew, British Museum (Nat. Hist.), Geneva, etc.; Urban, *Symb. Ant.* 3: 57. 1902.

HIGSON, THOMAS (1773–1836); English merchant; was curator of Bath Botanic Garden, Jamaica, 1828–32; Urban, *Symb. Ant.* 3: 61. 1902.

HJALMARSSON, JUSTUS ADALRIK (1823–1876); Swedish apothecary, who emigrated, in 1850, to St. Thomas, settling in Puerto Rico in 1857; in May 1858 visited the island of Grand Turk, Turks Islands, for 14 days; specimens at Kew and Göttingen; Urban, *Symb. Ant.* 3: 60. 1902.

IMRAY, JOHN (1811–1880); Scottish medical man; emigrated to Do-

minica in 1832, began investigation of flora of the island in 1837; specimens at Kew; Urban, *Symb. Ant.* 3: 67. 1902.

JACQUIN, NICOLAUS JOSEPH VON (1727–1817); Austrian botanist; born in Leyden, Netherlands, but of French descent; studied philosophy at Louvain, medicine and botany at Leyden, then at Paris; went, in 1752, to Vienna for the completion of his medical studies, became acquainted with the Emperor Franz I and was dispatched by him to the West Indies in 1755 to obtain plants and animals for the Imperial gardens and menagerie at Schönbrunn; between 1755 and 1759 visited St. Vincent, Grenada, Curaçao, Aruba, Venezuela, Guadeloupe, St. Christophers, St. Eustatius, St. Martin, St. Barthèlemy, Haiti, Jamaica (1758), Martinique and Cuba; later became professor of chemistry and botany in Vienna; some specimens in British Museum (Nat. Hist.), sold to Banks in 1777; Urban, *Symb. Ant.* 1: 75–78. 1898; 3: 65, 66. 1902; Dawson, *The Banks Letters* 447. 1958.

The results of Jacquin's botanical work were summarized in his *Enumeratio systematica Plantarum, quas in Insulis Caribaeis vicinaque Americes Continente detexit* (Leyden, 1760), a work of only 41 pages but nomenclaturally important for the first publication of genera and species later described and often illustrated in his folio *Selectarum Stirpium Americanarum Historia* (Vienna, 1763), of which a sumptuous limited new edition with colored illustrations copied direct for Jacquin's drawings was published about 1780.

LANE, A. W.; surgeon; visited Bermuda, Cuba, Jamaica, St. Thomas, Antigua, Grenada, and Trinidad some time before 1844; specimens at Kew; Urban, *Symb. Ant.* 3: 71. 1902.

LINDEN, JEAN JULES (1817–1898); Belgian horticulturist and plant-collector; born in Luxembourg; made his first collecting journey at the age of 18 to Brazil in 1835–37; his second, in 1837, to Cuba, Mexico, and Guatemala; his third, in 1841–45, to Venezuela, Colombia, Jamaica, and Cuba; on his return to Europe set up in Luxembourg an establishment for the introduction of new plants; directed, from 1852 to 1862, the Jardin Royal de Zoologie et d'Horticulture in Brussels; specimens at Kew, British Museum (Nat. Hist.), Geneva, Paris, etc.; Urban, *Symb. Ant.* 3: 76–78. 1902.

LOCKHART, DAVID (d. 1846); English gardener; accompanied Tuckey on the Congo expedition of 1816; sent, in 1821, to Trinidad to found a botanic garden, of which he was superintendent until his death in 1846; Trinidad specimens at Kew; Urban, *Symb. Ant.* 3: 78. 1902.

MACFADYEN, JAMES (1800–1850); Scottish medical man; studied medicine and natural history at Glasgow; went to Jamaica, in 1825, as Island Botanist but owing to lack of money resigned from this post and took up medical practice, devoting his spare time to botany and the preparation of his *Flora of Jamaica* (Vol. 1, 1837); unfortunately his death from cholera prevented the publication of Volume 2, of which 216 pages were printed, and his personal herbarium seems to have been destroyed; specimens at Kew; Urban, *Symb. Ant.* 1: 99. 1898; 3: 79, 80. 1902.

McNAB, GILBERT (1815–1859); Scottish medical man; third son of WILLIAM McNAB (1780–1848), brother of JAMES McNAB (1810–1878), uncle of WILLIAM RAMSAY McNAB (1844–89); emigrated, in 1838, to Jamaica and practiced in St. Ann and Kingston in association with James Macfadyen; specimens at Kew and Edinburgh; Urban, *Symb. Ant.* 3: 80. 1902.

MARCH, WILLIAM THOMAS (ca. 1795–ca. 1872); lawyer in Jamaica; lived at Spanish Town, where he had a fine garden; probably many plants recorded from Jamaica on the authority of specimens sent to Kew by March, but not since found in Jamaica in a wild state, were really garden-grown; specimens at Kew; Urban, *Symb. Ant.* 3: 81. 1902.

MASSON, FRANCIS (1741–1805 or 1806); Scottish gardener and plant-collector; sent out from Kew to collect at the Cape of Good Hope in 1772–74, to the Azores in 1776, Canary Islands in 1777, Madeira in 1778, Barbados and Grenada in 1779, St. Eustatius, Antigua, St. Kitts, St. Lucia, Nevis in 1780, Jamaica in 1781, then back to the Cape in 1786–95; in 1797 to North America, dying at Montreal in December 1805 or January 1806; specimens in British Museum (Nat. Hist.); Urban, *Symb. Ant.* 3: 82. 1902; M. C. Karsten in Jour. S. Afr. Bot. **24**: 203–218. 1958; **25**: 167–188, 283–310. 1959; **26**: 9–15. 1960; **27**: 15–45. 1961.

NICHOLSON, THOMAS (1799–1877); Scottish medical man; settled at St. Johns, Antigua, in 1822, returned to England in 1848 but went back to Antigua in 1849 and prepared a catalogue of Antiguan plants, the manuscript of which is at the University of the West Indies, Jamaica, with photocopy at British Museum (Nat. Hist.); Urban, *Symb. Ant.* 3: 92. 1902.

OERSTED, (ØRSTED), ANDERS SANDÖE (SANDØE) (1816–1872); Danish botanist; made, in 1845, a journey to the West Indies, in the course of which he visited St. Thomas, St. Croix, Grenada, and other isles of the Lesser Antilles, then went to Jamaica where he spent six weeks, botanizing with McNab and Macfadyen and ascending the Blue Mountain Peak; his *Skildring of Naturen pas Jamaica* (1856–57, reprinted in 1863) gives a general survey of the zoning of vegetation (summarized in Urban, *Symb. Ant.* 1: 118, 119. 1898); he then travelled in Costa Rica and Nicaragua, returning to Copenhagen in 1848; here he became professor in 1860; specimens at Copenhagen; Urban, *Symb. Ant.* 3: 93, 94. 1902; Christensen, *Danske Bot. Hist.* 1: 377–420. 1925; 2: 232–244. 1929.

PURDIE, WILLIAM (1817–1857); Scottish gardener trained at Edinburgh under William McNab; sent out to Jamaica in 1843 by W. J. Hooker to collect seeds, plants, and specimens; travelled extensively and collected with great success over much of the island; left Jamaica in April 1844 for Colombia, where in May–July 1844 he collected on the Sierra Nevada de Santa Marta, then elsewhere in Colombia in 1844–46, leaving Colombia in 1846 to become government botanist and superintendent of the Botanic Garden, Port of Spain, Trinidad; visited Venezuela in 1851 and Puerto Rico in 1854; died in Trinidad 14 October 1857; specimens at Kew, some duplicates in Paris; Urban, *Symb. Ant.* 3: 107; Ewan, J.,

"A review of *Purdieanthus* and *Lehmanniella* . . . and biographical notes on Purdie and Lehmann," Caldasia **5**: 85–98. 1948.

Purdie's route in Jamaica, as revealed by his letters and localities on specimens at Kew, may be summarized as follows:

1843

ST. ANDREW: 14 May, arrived at Kingston; 19 May, left for Port Royal Mountains with Hartweg, crossed Liguanea Plain, reached Flamstead; 22 May, reached St. George's Gap; 24 May, returned to Kingston. ST. CATHERINE: 26 May, to Spanish Town; 27 May, along gorge of Rio Cobre to W. McNab's residence at Woodbridge. ST. ANDREW: 31 May, returned to Kingston by way of Stony Hill; 6 June, set out for Blue Mountain Peak, reached Penn Hill. ST. THOMAS: 7 June, crossed Yallah's River, reached Radnor Coffee Plantation in Blue Mountains; 8 June, at Portland Gap; 12 June, reached Blue Mountain Peak, stayed overnight; 13 June, returned to Radnor. ST. ANDREW: 16 June, to Resource; 17 June, to John Crow Ridge; 18 June, to Morce's Gap. PORTLAND: 20 June, to Spring Hill, by way of Silver Hill and Shentamee; 23 June, to Fox's Gap at junction of St. Andrew, Portland, and St. Mary Parishes. ST. THOMAS: 25 June, back to Radnor; 27 June, back to Portland Gap. ST. ANDREW: 28 June, returned to Kingston by way of Guava Ridge. ST. THOMAS: 7 July, set out for Bath, along coast by way of Albion, the Salt Ponds and White Horses to Morant Bay; 8 July, Port Morant and Bath Botanic Garden; 10 July, Plantain Garden River and Wheelersfield; 11 July, to Quaw Hill and Holland Bay; 12 July, John Crow Hill; 13 July, Holland Bay and Morant Point; 14 July, back to Bath with fever; 19 July, to Cuna Cuna Pass and into Portland to Golden Vale estate. PORTLAND: 20 July, by way of Moretown to Port Antonio, Blue Hole, Turtle Crawle, Fairy Hill; 21 July, back to Golden Vale; 22 July, back to Bath. ST. THOMAS: 24 July, to Golden Valley and up to the Plantain Garden River; 25 July, to Dunrobin Castle; 26 July, back to Bath; 1 August, White Hall; 2 August, Morant River, then to Windsor Forest, Woburn Lawn; 3 August, by way of Hagley Gap, back to Kingston. ST. CATHERINE: 9 August, by way of Ferry, to Twickenham Park. ST. ANDREW: 10 August, Red Hills. ST. CATHERINE: 11 August, Ferry, Spanish Town, Guanaboa, Twickenham Park, Caymanas, Ferry; 14 August, visited lagoons near Ferry by boat, returned to Kingston; 23 August, by boat to Apostles Battery, Port Henderson, and vicinity. Purdie's route hereafter is not well documented. September, Guys Hill. ST. MARY: 6 October, reached Kingston from St. Mary and Pedro district of ST. ANN. 29 October, left for MANCHESTER; 19 November, Great Valley, Manchester; then to Maroon Town, TRELAWNY.

1844

January, Montego Bay, ST. JAMES; then to Lucea and Orange Bay, HANOVER, thence to interior of WESTMORELAND, visiting Dolphin Head (HANOVER) and Bluefields Mountain (WESTMORELAND), and to ponds of ST. ELIZABETH. 9 March, salt marshes near Kingston, ST. ANDREW. 23 March, to Pedro district of ST. ANN. April, Roaring River, ST. ANN. May arrived Santa Marta, Colombia. Several species recorded by Grisebach from Jamaica, e.g. *Drymonia parviflora* and *Pinguicula elongata*, were, in fact, based on specimens collected by Purdie in Colombia.

A letter of J. H. Hart written on 12 June 1896 to the Royal Botanic Gardens, Kew, calls attention to confusion between St. Anns, Port-of-

Spain, Trinidad, and the Parish of St. Ann, Jamaica; "several species credited to St. Anne's, Jamaica, have not been re-found and it may be well to note that locality as doubtful. From many circumstances I feel diffident about attaching any importance to Purdie's specimens from St. Anne's, Jamaica, most of the specimens so credited being found in St. Anne's, Trinidad, the district in which the Botanic Gardens are situated."

RUGEL, FERDINAND IGNATIUS XAVIER (1806–1879); German pharmacist and plant-collector; born at Wolfegg on the Ach near Weingarten, Württemberg, on 17 December 1806; went to Switzerland, thence, in 1840, to the United States, collecting at cost of R. J. Shuttleworth in 1846 in southern Florida, including Key West, and in 1849 in Cuba (mostly in the province of Matanzas); settled then in Jefferson County, eastern Tennessee, where he died on 31 January 1879; specimens at Kew, British Museum (Nat. Hist.), Göttingen, Leyden, New York, etc.; Urban, *Symb. Ant.* 3: 115, 116. 1902; S. W. Geiser, "Biographical note on Dr. Ferdinand Rugel, American botanist," *Field & Laboratory* 16: 113–119. 1949; S. W. Geiser, "Birthplace of Ferdinand Rugel (1806–79), early Southern botanist," *Field & Laboratory* 18: 112. 1950.

RYAN, JOHN (d. 1808); English medical man; plantation owner on island of Montserrat towards end of the 18th century; returned to England in 1792 but owing to customs difficulties at Plymouth sent his specimens on to Copenhagen, whence they were later sent to Banks in London; specimens in British Museum (Nat. Hist.) and Copenhagen; Martin Vahl published descriptions of them in his *Eclogae Americanae* (1796–1807) and *Icones* (1798–99), the last at Ryan's expense; Urban, *Symb. Ant.* 1: 173. 1898; Dawson, *The Banks Letters* 727. 1958.

SCHACK, BARON VON (d. 1824), Austrian; lived for many years in Trinidad and sent living plants from there to the botanic gardens of Glasgow and Liverpool; specimens at Kew; Urban, *Symb. Ant.* 3: 119. 1902.

SCHOMBURGK, SIR ROBERT HERMANN (1804–1865); German botanist, brother of SIR MORITZ RICHARD SCHOMBURGK (1811–1890); collected during 1835–44 in British Guiana, northern Brazil, and Venezuela; knighted in 1844 by Queen Victoria for his achievements as an explorer; spent 11 months (1846–47) in Barbados; was British consul from 1848 to 1857 in Santo Domingo; specimens in Kew, British Museum (Nat. Hist.), Paris, and Berlin; Urban, *Symb. Ant.* 3: 121. 1902.

SIEBER, FRANZ WILHELM (1789–1844); Austrian plant-collector and dealer in herbarium specimens at Prague; collected himself in Italy, Crete, Egypt, Palestine, Mauritius, Australia, and South Africa, but collections were made for him by Franz Kohaut in Martinique in 1820 (specimens distributed as "Flora Martinicensis") and by Franz Wrbna in Trinidad in 1722 (specimens distributed as "Flora Trinitatis"); some confusion of localities may have occurred; specimens in many herbaria; Urban, *Symb. Ant.* 3: 127. 1902; Maiwald, *Gesch. Bot. Böhmen* 111–116. 1904.

SLOANE, SIR HANS (1660–1753); Irish medical man and botanist; studied medicine in London, Paris, and Montpellier, then voyaged, in

1687, to Jamaica as personal physician to the Governor, the Duke of Albemarle, by way of Madeira, Barbados, Nevis, and St. Kitts; was in Jamaica from December 1687 to March 1689; although resident in St. Jago de la Vega, now Spanish Town (St. Catherine), and evidently restricted by his professional duties, Sloane managed nevertheless to travel in the parishes of St. Andrew, St. Mary, and St. Ann, ranging in the north from St. Ann's Bay to Rio Nuevo; on his return became a very successful and wealthy doctor; knighted in 1716, made President of the Royal College of Physicians in 1719, and President of the Royal Society in 1727; published first a *Catalogus Plantarum quae in Insula Jamaica sponte provenient* (1696), then his two-volume *Voyage to the Islands Madera, Barbados, Nieves, S. Christophers and Jamaica with the Natural History . . . of the last of those Islands* (Vol. 1. 1707; vol. 2. 1725), which contains accurate descriptions and illustrations of his plants; specimens contained in volumes 1–8 of the Sloane Herbarium in the British Museum (Nat. Hist.), London. Urban, *Symb. Ant.* 1: 154–157. 1898; 3: 130. 1902; G. R. de Beer, *Sir Hans Sloane and the British Museum* (1953); E. St. John Brooks, *Sir Hans Sloane, the great Collector and his Circle* (1954); J. E. Dandy (*ed.*), *The Sloane Herbarium* (1958).

Spruce, Richard (1817–1893); English botanist; began as a school teacher; from 1849 to 1864 travelled to South America (Brazil, Colombia, Ecuador, Peru, and Venezuela), making immense and botanically most valuable collections; then returned to England in bad health and spent the rest of his life as an invalid in a humble Yorkshire cottage, courageously and diligently, although in frequent pain, monographing South American Hepaticae. The major results of his study are embodied in his *Hepaticae Amazonicae et Andinae* (1884–85); he did not collect in the West Indies, but his specimens, distributed to numerous herbaria, serve for comparison with material from Trinidad; Spruce, *Notes of a Botanist on the Amazon and Andes* (2 vols. 1908).

Swainson, ——— (fl. 1830–1842); collected in the Bahamas; not to be confused with the zoologist William Swainson (1789–1855); specimens at Kew; Urban, *Symb. Ant.* 3: 134. 1902.

Swartz, Olof (1760–1818); Swedish botanist; studied natural history and medicine at Uppsala; went in August 1783 to North America, then to the West Indies, leaving Boston on 26 Nov. 1783, landing at Montego Bay, Jamaica, on 5 Jan. 1784; stayed for some time on the Hampden estate, Trelawny, travelled between January and August 1784 in Hanover, St. Elizabeth, and Westmoreland, visited Savanna-la-Mar, later Kingston and from here, in 1785, ascended Blue Mountain Peak (East Peak) and stayed with Matthew Wallen of Coldspring, St. Andrew, in the Blue Mountains, and visited Catherine Peak (Catherine Hill), as well as the Liguanea Plain, Ferry, and Spanish Town in St. Catherine, and Morant Bay, Bath, and Manchioneal in St. Thomas; visited Cuba and Haiti; in 1786 brought his collections to London and worked them out with the aid of Dryander in Sir Joseph Banks's house at Soho Square, London, presenting Banks with specimens of Jamaican species not al-

ready represented by specimens collected by Mason, Shakespear, and Wright; in autumn of 1787 returned to Sweden; published between 20 June and 31 July 1788 his *Nova Genera et Species Plantarum seu Prodromus* (facsimile in 1962) briefly characterizing many West Indian plants, then *Observationes botanicae* (1791) giving critical observations on species already but often imperfectly known, *Icones Plantarum incognitarum* (1794–1800), *Flora Indiae occidentalis* (1797–1806) and other works; in 1789 became keeper of the Royal Natural History Collections at Drottingholm, in 1791 professor at the Hortus Bergianus, Stockholm, in 1807 keeper of the museum of the Royal Academy of Sciences; specimens in British Museum (Nat. Hist), London (from Herb. Banks), Riksmuseum in Stockholm (Swartz's personal herbarium), Linnean Society of London (in Smith Herbarium), Geneva (in Prodromus Herbarium), Copenhagen, Munich, etc.; original drawings listed by Urban in *Symb. Ant.* 1: 164, 165. 1898, now in Library of Royal Academy of Sciences, Stockholm (see p. 284); Swartz, *Adnotationes botanicae* (1829); Urban, *Symb. Ant.* 3: 134, 135. 1902.

WATERS, JAMES (fl. 1826–1847); English clergyman; collected specimens in Jamaica which are at Kew; Urban, *Symb. Ant.* 3: 139. 1902.

WILES, JAMES (fl. 1791–1805); English gardener; sailed with Captain Bligh on his second voyage (1791–93) to introduce the breadfruit (*Artocarpus communis*) into the West Indies from the Pacific, was successful in establishing this first in the botanic gardens of St. Vincent, then in Jamaica; specimens in British Museum (Nat. Hist.); Urban, *Symb. Ant.* 3: 140. 1902.

WILSON, NATHANIEL (1809–74); Scottish gardener; emigrated to Jamaica and became Island Botanist and Superintendent of Botanic Garden at Bath; founded Castleton Garden in 1860; in 1857–58 made collections in many parts of Jamaica, including Dolphin Head and around Manchioneal; specimens at Kew, British Museum (Nat. Hist.); Urban, *Symb. Ant.* 3: 140. 1902.

WOODFORD, SIR RALPH (1784–1828); Governor of Trinidad, 1813–28; specimens at Kew; Urban, *Symb. Ant.* 3: 141. 1902.

WRIGHT, WILLIAM (1735–1819); Scottish medical man; settled in Jamaica, in 1765, on Hampden Estate, Trelawny; returned to Britain in 1777–79; on voyage back to Jamaica as regimental surgeon to the newly raised Jamaica Regiment in 1779 was captured by a combined Spanish and French fleet, and interned in Spain; returned in 1782 to Jamaica, where he was visited by Swartz; returned to England in 1785; specimens at Kew, British Museum (Nat. Hist.), Edinburgh, Brussels; Urban, *Symb. Ant.* 3: 143. 1902; W. Fawcett, "William Wright, a Jamaican botanist," Jour. Bot. (London) 60: 330–334. 1922.

WULLSCHLÄGEL, HEINRICH RUDOLF (1805–1864); missionary belonging to the Moravian Brothers; 1844–47 in Antigua (herb. nos. 1–760), 1847–49 in Jamaica (herb. nos. 761–1345), in parish of Manchester; main herbarium at Munich, some duplicates at Göttingen; Urban, *Symb. Ant.* 3: 145. 1902.

COLLECTORS GROUPED BY ISLANDS

The following conspectus lists chronologically under each island the botanical travellers and residents in the British West Indies who, by collections or records, contributed to a knowledge of their flora down to the year 1900. It has been extracted with slight modification from Urban's more extensive "Conspectus insularum earumque peregrinatorum botanicorum" in *Symbolae Antillanae* 3: 147–158. 1902. Persons listed within brackets, e.g. [J. B. Labat between 1694–1705], are not known to have left herbarium specimens although they made notes, sometimes incidental, on plants. Collectors cited by Grisebach are italicized, e.g. *O. Swartz*.

Antigua

P. Browne 1745
F. Masson 1780
de Ponthieu before 1786
L. Cl. Richard 1786–1787
W. Hamilton ca. 1814
F. L. l'Herminier 1815
T. Nicholson ca. 1831–1841
Ch. Breutel 1841 (chiefly Crypt.)
A. W. Lane before 1844
H. R. Wullschlägel 1844–1847
K. Finlay ca. 1850
A. G. Tillson 1889–1897
H. A. A. Nicholls 1890–1891
C. A. Barber 1891–1895

Bahamas

M. Catesby 1725–1726
F. Boos, F. J. Märter & [J. D. Schöpf] 1784
A. Michaux 1789
J. Fraser 1802
Crudy before 1810
Swainson 1830–1842
W. F. Daniell 1857–1858
J. Hjalmarsson 1858
W. Cooper 1859
R. W. Rawson 1867–1868
H. E. W. Robinson 1877
L. J. K. Brace 1877–1880
A. H. Searing ca. 1885
F. H. Herrick 1886
[J. Gardiner 1886–1888]
C. S. Dolley ca. 1887
H. von Eggers 1887, 1888
A. S. Hitchcock 1890
J. I. & A. B. Northrop 1890
D. Morris 1895

Barbados

[R. Ligon 1647–1650]
H. Sloane 1687
J. Reid 1692
[J. B. Labat between 1694–1705]
P. Browne 1745
[G. Hughes before 1750]
F. Masson 1779
A. Anderson between 1785–1811
J. Gregg before 1786
Martfelt before 1791
W. Wright 1796–1798
F. Seaforth ca. 1803
T. W. Simmonds 1803–1804
F. Pursh 1810–1811
W. Hamilton ca. 1814
C. S. Parker ca. 1825
[J. D. Maycock before 1837]
A. W. Lane before 1844
Rob. Schomburgk 1846–1847
W. Munro 1870–1876
W. B. Murray ca. 1871
O. Kuntze 1874
R. W. Rawson before 1875
C. S. Sargent 1885
E. H. L. Krause 1890
H. von Eggers 1890, 1891
E. Warming 1891
J. H. Hart ca. 1895
J. F. Waby 1895

BARBUDA

de Ponthieu before 1786
L. Cl. Richard 1786–1787
H. A. A. Nicholls 1891

DOMINICA

[J. B. Labat between 1694–1705]
J. Gregg before 1786
F. Pursh 1810–1811
[J. B. Ricord-Madianna between 1821–1825]
J. Imray 1837–1880
Hoskin 1841
K. Finlay ca. 1850
Murray
H. von Eggers 1880–1883
[W. Schimper 1881, 1883]
F. Johow 1882–1883
A. Duss 1883, 1885
H. A. A. Nicholls since 1886
G. A. Ramage 1888–1889
J. J. Walsh ca. 1889
W. R. Elliott 1892, 1894, 1895 to 1896 (Crypt.)
C. A. Barber ca. 1893

GRENADA

[J. B. du Tertre ca. 1650–1656]
[J. B. Labat between 1694–1705]
N. J. Jacquin between 1755–1757
F. Masson 1779
A. Anderson between 1785–1811
de Ponthieu before 1786
A. W. Lane before 1844
A. S. Oersted 1845–1846
K. Finlay ca. 1850
R. W. Rawson 1870–1872
G. Murray 1886 (Algae)
W. R. Elliott 1886–1889 (Pterid.)
H. von Eggers 1889
J. J. Walsh ca. 1889
R. V. Sherring 1890–1891
G. W. Smith 1890–1894
D. W. Alexander 1891
W. E. Broadway since 1894
J. H. Hart ca. 1895

JAMAICA

J. Harlow ca. 1670
H. Barham 1680–1726
H. Sloane 1687–1689
W. Houstoun between 1729–1733
P. Browne 1746–1755
[E. Long ca. 1755–1769]
N. J. Jacquin 1758
A. Robinson before 1768
W. Wright 1771–1777, 1782–1785
Th. Dancer 1773–1811
R. Shakespear 1777–1782
F. Masson 1781
O. Swartz 1784, 1785–1786
de Ponthieu before 1786
J. von Rohr 1786
F. J. Märter 1786–1787
J. Wiles 1793–1805
A. Broughton before 1800
F. R. deTussac 1802
E. N. Bancroft 1811–1842
[J. Lunan before 1814]
C. Bertero 1821
G. Don 1822
R. Heward 1823–1826
J. Macfadyen 1825–1850
J. Waters ca. 1826–1830
Murray 1827
Th. Higson 1828–1836
H. Distin 1830–1840
H. Cuming 1831
G. McNab 1838–1859
Th. Hartweg 1843
W. Purdie 1843–1844
H. J. Krebs between 1843–1866
A. W. Lane before 1844
W. A. Bromfield 1844
P. H. Gosse 1844–1845
A. S. Oersted 1846
N. Wilson 1846–1858
H. R. Wullschlägel 1847–1849
R. C. Alexander Prior 1849–1850
F. H. Taylor 1852–1854 (Pterid.)
H. Barkly 1853–1856
W. T. March especially 1857–1858
W. F. Daniell ca. 1863
G. S. Jenman 1873–79 (Pterid.)

B. Baker (Pterid.)
Kendal (Pterid.)
T. L. Rees (Pterid.)
S. Roberts (Pterid.)
S. B. Wilson 1874 (Pterid.)
W. Nock 1875–1880 (Pterid.)
Lady O'Malley 1877
G. Syme 1879–1884
D. Morris 1879–1886
R. V. Sherring 1880–1887
F. C. Lehmann 1881
J. H. Hart 1881–1887
C. S. Sargent 1885
W. Fawcett since 1887
H. von Eggers 1888
W. J. Thompson since 1889
D. E. Watt ca. 1890
A. S. Hitchcock 1890
E. H. L. Krause 1890
J. E. Humphrey 1893, 1897 (Crypt.)
[A. Worsley 1894]
W. Cradwick since 1894
W. Harris since 1894
E. Campbell 1894–1896
B. D. Gilbert 1895 (Pterid.)
A. Fredholm 1897
O. Hansen 1897
C. F. Millspaugh 1899, 1900

MONTSERRAT

P. Browne 1745
J. Ryan ca. 1780
de Ponthieu before 1786
J. von Rohr 1786
H. K. Holme ca. 1878
H. A. A. Nicholls 1890–1891
C. A. Barber ca. 1893

ST. KITTS (ST. CHRISTOPHER)

[J. B. du Tertre ca. 1650–1656]
H. Sloane 1687
[C. Plumier between 1689–1697]
[J. B. Labat between 1694–1705]
P. Browne 1745
N. J. Jacquin between 1755–1757
F. Masson 1780
S. Fahlberg between 1785–1834
B. A. Euphrasén 1788
W. Hamilton ca. 1814
Ch. Breutel 1841 (chiefly Crypt.)
J. R. Elsey 1857
H. von Eggers 1882
C. S. Sargent 1885
W. F. R. Suringar 1885
J. J. Walsh ca. 1889
C. A. Barber ca. 1893

ST. VINCENT

[C. Plumier between 1689–1697]
[J. B. Labat between 1694–1705]
N. J. Jacquin between 1755–1757
G. Young 1765–1774
A. Anderson 1785–1811
W. Lochead 1811–1815
G. Caley 1816–1823
L. Guilding 1817–1833
J. Macrae 1823
C. S. Parker ca. 1825
H. von Eggers 1889–1890
H. H. & G. W. Smith 1889–1890
E. H. L. Krause 1890
H. A. A. Nicholls 1890–1891
W. R. Elliott 1891–1892 (Crypt.)
H. Powell 1891–1893
J. H. Hart ca. 1895

SANTA LUCIA

[J. B. du Tertre ca. 1650–1656]
[J. B. Labat between 1694–1705]
J. B. Leblond ca. 1767
F. Masson 1780

TOBAGO

[de Rochefort before 1665]
G. Young ca. 1765
J. Gregg before 1786
de Ponthieu before 1786
W. Hamilton ca. 1814
F. L. l'Herminier
L. C. Meyer 1879
H. von Eggers 1889, 1891, 1899
Th. Clemens 1890–1891
H. A. A. Nicholls 1890–1891
J. H. Hart ca. 1895
A. Seitz 1896

TRINIDAD

[G. F. de Oviedo between 1519–1556]
J. B. Leblond ca. 1767
Ryan ca. 1780
A. Anderson between 1785–1811
J. von Rohr 1786
N. Baudin, A. P. Ledru, A. Riedlé 1797
R. Woodford 1813–1828
D. Lockhart 1818–1846
von Schack ca. 1820
F. Wrbna (for *Sieber*) 1822
C. S. Parker ca. 1825
H. Crueger 1841–1864
A. W. Lane before 1844
W. A. Bromfield 1844
Bradford 1845–1846
W. Purdie 1846–1857
K. Finlay ca. 1850–1868
Germain ca. 1860 (Crypt.)
H. Prestoe 1864–1886
O. Kuntze 1874
A. Fendler 1877–1883
F. Johow 1882–1883
[W. Schimper 1882–1883]
H. von Eggers 1883, 1899
R. V. Sherring 1885–1886 (Pterid.)
J. H. Hart since 1887
W. E. Broadway 1888–1894
D. W. Alexander 1890 seq.
E. Warming 1891
Baptiste 1891–1896
W. Lunt 1894–1898
F. A. Lodge since 1899

LITERATURE CITED BY GRISEBACH[6]

Grisebach's references to literature in the *Flora* are restricted for the most part to concise citations of plates and figures. Although many of these are self-evident, a number require much amplification in order that the works concerned can be traced in a library catalogue. After each entry below are given references to G. Pritzel's *Thesaurus Literaturae botanicae*, 2nd ed. (1872) cited as "Pr." with an entry number, to Urban's "Bibliographia Indiae occidentalis botanica" in I. Urban, *Symbolae Antillanae* 1: 1–179. 1898, cited as "Urb. 1" with a page number, to C. Nissen's *Die botanische Buchillustration* 2. 1951, cited as "Niss." with an entry number, and to C. Stevenson's *Catalogue of botanical Books in the Collection of Rachel M. M. Hunt* 2. (II). 1961, cited as "Hunt" with an entry number.

[6] Since this paper was set in type the author has sent a series of additional references which we are glad to cite here under the same abbreviated citations as in the text. *Ed.*

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THE GENERA OF TILIACEAE AND ELAEOCARPACEAE IN THE SOUTHEASTERN UNITED STATES [1]

GEORGE K. BRIZICKY

TILIACEAE A. L. de Jussieu, Gen. Pl. 289. 1789, nom. cons.

(LINDEN FAMILY)

Trees to perennial or annual herbs woody at base, usually pubescent with simple and/or stellate hairs; inner bark fibrous; mucilage cells and cavities or, more rarely, ducts, in inner bark and often in pith, leaves, and flowers. Leaves alternate, simple, usually palmately veined at base, sometimes palmately 3[–7]-lobed, toothed, petioled, stipulate, the stipules usually small, caducous to persistent. Inflorescences bracteate, simple, solitary or fascicled cymes, sometimes reduced to solitary flowers, opposite the leaves or ± leafy bracts, or axillary and/or terminal, sometimes forming cymose panicles or thyrses. Flowers pediceled, small [to large], regular, hypogynous, 5[4]-merous, usually bisexual. Sepals [4] 5, distinct [or connate], sometimes nectariferous at base within, valvate in aestivation. Petals [4] 5, distinct, usually yellow or yellowish, sometimes nectariferous at base within, imbricate or convolute in aestivation [or wanting]. Nectariferous disc, when present, extrastaminal, encircling the stamens, cup-, ring-, or disclike, somewhat fleshy to membranaceous, on the flat receptacle or at apex of an androgynophore. Androgynophore present or absent. Stamens numerous (rarely few), usually distinct [reduced and sterile in ♀ flowers], the 5 innermost [or 5 to many outermost] sometimes staminodia; filaments elongated, filiform, sometimes bifurcate at apex; anthers introrse or extrorse, the anther halves contiguous or separated at the tips of the bifurcate filament, dehiscent by longitudinal [or apical] slits; pollen medium sized [rarely large], usually 3-colporate, oblate to prolate, subreticulate or reticulate, the pattern often very complicated. Gynoecium usually 2–5-carpellate, syncarpous [rudimentary in ♂

[1] Prepared for a generic flora of the southeastern United States, a joint project of the Arnold Arboretum and the Gray Herbarium of Harvard University made possible through the support of George R. Cooley and the National Science Foundation and under the direction of Carroll E. Wood, Jr., and Reed C. Rollins. This treatment follows the pattern established in the first paper in the series (Jour. Arnold Arb. **39**: 296–346. 1958) and continued through those in volumes 40–46 (1959–1965). The area covered is bounded by and includes North Carolina, Tennessee, Arkansas, and Louisiana. The descriptions are based primarily on the plants of this area, with any supplementary material in brackets. References which the author has not seen are marked by an asterisk.

The author is indebted to Dr. Wood for his many valuable suggestions; to Mrs. Gordon W. Dillon for her help in the preparation of the typescript; and to Dr. Olga Lakela for information about the distribution of *Muntingia* in Florida. The illustration was drawn by Mr. Arnold D. Clapman from materials collected by Dr. Wood.

flowers]; stigma large or small, usually lobed; style single; ovary superior, usually 2–5-locular, sometimes appearing 3–10-locular through development of false partitions; ovules axile, in two rows, numerous to 2 [very rarely 1] in a locule, ascendent to pendulous, anatropous, apo- to epitropous, 2-integumented, with a thick nucellus. Fruit nutlike or a drupe [rarely a berry], capsule, or schizocarp, sometimes prickly [or winged]. Seed with [or without] endosperm, the embryo large, "spatulate" or "folded." TYPE GENUS: *Tilia* L.

An almost exclusively pantropical family of about 45 genera and over 400 species; only *Tilia* and the monotypic *Entelea* R. Br. (New Zealand) primarily of the Temperate zones; three genera (one naturalized) in our area. Four subfamilies and 16 tribes have been recognized in the family. The genera usually are well marked, especially on the basis of fruit characters. The three genera of our area have been placed in subfam. Tilioideae, but the delimitation of this group appears to be uncertain, at least from the standpoint of pollen morphology (cf. *Tilia*).

Although data on floral biology are scarce, the usually showy flowers provided with various types of nectaries indicate that the family in general is adapted to insect-pollination. The flowers usually are bisexual, although part or all of the species of some genera are dioecious. Staminate flowers usually possess a rudimentary gynoecium, while carpellate flowers show antheriferous but sterile stamens. The androecium is basically two-seriate (diplo- or obdiplostemonous), but one series, often the antisepalous one, is sometimes completely suppressed. The usually numerous stamens supposedly have arisen by multiplication of an originally smaller number, in either one or both series. Indications of multiplication are seen in the splitting of staminal traces. Floral anatomical and embryological data are known for only a few genera of the family. The development of the embryo conforms to the Urtica variation of the Asterad-type. The placentation of the ovary usually is axile, apparently derived from the parietal condition which is still encountered in some species of a few genera (e.g., *Trichospermum* Blume subg. *Coelomesum* Burret).

Chromosome counts recorded for 18 genera (41 species) are $2n = 14$, 16, 18, 28, 30, 32, 36, 40, 48, 82, and 164, suggesting that disploidy, polyploidy, and aneuploidy have been of importance in the evolution of Tiliaceae.

The family is closely related to Scytopetalaceae, Sterculiaceae, Elaeocarpaceae, Bombacaceae, and Malvaceae, which together form a very natural order, Malvales (Columniferae), within which the family limits are often weak and uncertain. Derivation of this order from Dilleniaceae is thought possible.

A few Tiliaceae yield commercial timbers. Some species of *Corchorus*, *Triumfetta*, *Grewia* L., *Honckenya* Willd., etc., yield fibers, either for commercial or local use. Species of *Sparmannia* L. f., *Grewia*, and *Entelea* are grown as ornamentals in warm parts of the country; *Grewia biloba* D. Don is hardy as far north as southern New England.

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KEY TO THE GENERA OF TILIACEAE

General characters: *trees to herbs; hairs simple and/or stellate; leaves alternate, simple, toothed, petioled, stipulate; inflorescences cymose; flowers small, regular, hypogynous, bisexual; perianth 5-merous, sepals and petals distinct; stamens numerous, sometimes in 5 antipetalous fascicles, rarely 5–10, distinct; gynoecium 2–5-carpellate, ovules many to 2 in each locule; fruit nutlike and indehiscent or capsular and loculicidally dehiscent.*

A. Plants arborescent; inflorescences small, axillary, corymb-like, cymose panicles, with a long peduncle adnate to half its length with a conspicuous wing-like bract; stamens in five antipetalous fascicles, the five innermost stamens modified into petaloid staminodia; filaments forked at apex, each branch bearing a half-anther; gynoecium 5-carpellate; fruit nutlike, smooth. . . . . 1. *Tilia*.

A. Plants suffruticose or herbaceous, woody at base; inflorescences small, minutely bracteate, short-peduncled dichasial cymes, ± opposite leaves or leafy bracts; stamens numerous, not fasciculate, rarely 5–10, all fertile; filaments not forked, the anther-halves contiguous; gynoecium 2- or 3-carpellate.

B. Cymes solitary, opposite foliage leaves; sepals unappendaged at apex; stigma conspicuous, disclike; ovary usually sessile; fruit a smooth, podlike loculicidal capsule, with many minute, irregularly shaped, truncate seeds. . . . . 2. *Corchorus*.

B. Cymes in fascicles of 2–5, opposite much reduced leaves or leaf-like bracts, appearing to form axillary and/or terminal, narrow, raceme-like panicles; each sepal with a subapical hornlike appendage; stigma inconspicuous, minutely 2- or 3-lobed; ovary and androecium on a short, glanduliferous androgynophore; fruit nutlike, globular to nearly ovoid, covered with prickles hooked at apex, few-seeded, the seeds small, ovoid. . . . . 3. *Triumfetta*.

Tribe TILIEAE [Benth.]

1. **Tilia** Linnaeus, Sp. Pl. 1: 514. 1753; Gen. Pl. ed. 5. 230. 1754.

Large deciduous trees; terminal buds aborting, the branching thus sympodial; axillary winter buds with 2 or 3 unequal bud scales; indument of simple and/or stellate hairs. Leaves 2-ranked, ovate to suborbicular-ovate, 5–25 cm. long, usually obliquely cordate to truncate at base, glabrous to densely pubescent beneath, often with tufts of whitish or brownish [rusty] hairs in the axils of lateral and/or basal veins; stipules ligulate, caducous. Inflorescences axillary, few- to many-flowered, corymb-like cymose panicles, with minute caducous bracts, manifestly peduncled, the peduncle adnate to half its length to a membranaceous, oblong to obovate, reticulate-veined, partly free winglike bract. Flowers bisexual [rarely also ♂ by abortion, the plants then polygamous], fragrant. Sepals thickish, ± boat shaped, usually stellate-hairy without, each with a transverse, nectariferous, partly hairy gland at base within. Petals longer than sepals, narrow, creamy to yellow [pinkish], imbricate. Stamens numerous, usually shorter than petals and fully developed style, in 5 antipetalous fascicles (in ours), ± cohering at base with each other within each fascicle, the innermost stamen in each group modified into a spatulate, petaloid staminode [except in some Old World species]; filaments whitish, shortly bifurcate at apex, each division bearing a dorsifixed, extrorse half-anther (1-locular at anthesis) [or filaments entire with undivided anthers]; pollen medium sized, flattened at the poles, finely subreticulate. Gynoecium usually 5-carpellate [rudimentary in ♂ flowers]; stigma 5-lobed at maturity; style elongated, slender; ovary usually 5-locular; ovules 2 in each locule, axile, slightly superposed (almost collateral), ascendent, anatropous, apotropous. Fruit dry, nutlike, with a thin, parenchymatous outer layer and a thickish, woody [or crustaceous] endocarp, subglobular [or ellipsoid to obovoid], smooth [or (4)5-ribbed longitudinally], ± tomentose [to glabrate], 1-locular by obliteration of partitions, 1(–4)-seeded. Seed obovoid; seed coat cartilaginous, brown, with a large whitish scar and short, adaxial raphe; endosperm fleshy; embryo large, "folded," the cotyledons foliaceous, cordate, palmately 5-veined and 5-lobed, somewhat plaited in the middle, revolute toward abaxial surface of seed, the radicle straight, inferior. LECTOTYPE SPECIES: *T. europaea* L.; see N. L. Britton, N. Am. Trees 684. 1908. (Classical Latin name for some European species of the genus, probably derived from Greek, *ptilon*, wing, in allusion to the winglike bract of the inflorescence.) — LINDEN, BASSWOOD.

A genus of perhaps 40 (18–65) species,[2] primarily of the North Temperate Zone, with one species reaching subarctic Europe, about nine sub-

[2] "As sharply as the genus *Tilia* is distinguished from the related groups [genera] by a number of peculiar characters, just so difficult is the classification within the genus. The number of species can not be indicated with certainty, because all species are connected with one another by transitions [transitional forms], geographic races, and numerous hybrids" (Jaccard & Frey, p. 3). (Translation supplied.)

tropical Asia, and one or two Mexico; absent from the Himalayas and Pacific North America. In eastern North America, *Tilia* occurs in rich woods from Nova Scotia, New Brunswick, and southern Quebec, southward to central Florida, and westward to central and western Texas, Oklahoma, and the eastern parts of Kansas, Nebraska, South and North Dakota, and southern Manitoba. In Mexico, the genus ranges from northern Coahuila, southward along the Sierra Madre Oriental to southern Mexico, with scattered stations in the Sierra Madre Occidental (McVaugh). There is great uncertainty regarding the number and delimitation of the species of *Tilia* within this broad range, because the characters used for distinguishing the species (e.g., presence or absence, amount, color, and type of pubescence on the lower surface of mature leaves; size, shape, and texture of leaves; and shape and size of leaf teeth) seem to be quite inconstant (apparently from frequent hybridization and introgression) and hardly of specific significance. The current tendency is to reduce the 15 species recognized in the United States by Sargent (1922) and the 14 distinguished in the southeastern United States by Bush (in Small, 1933) to four or even to one.[3] For example, Braun (1961), who recognized in Ohio three "well-marked and fairly constant species" (*T. americana* L., *T. heterophylla* Vent., and *T. floridana* (V. Engl.) Small) and a species-complex (*T. neglecta* Spach), noted: "The taxonomy of the American species of *Tilia* is much confused. No two manuals agree, either in number of species recognized or in characters and limits of species. Until detailed field studies, over the entire range of the genus in America, are undertaken to determine probable hybridization and subsequent introgression resulting from Pleistocene migrations and commingling of older species, no satisfactory treatment is possible."

In wrestling with *Tilia* in northern Florida, Kurz and Godfrey (pp. 230, 231) remark, "It is of more than passing interest that our material was subsequently borrowed by a student of *Tilia* and that individual herbarium specimens taken from separate parts of a single tree were designated by him with more than one species name . . . Granting the fact that local populations of *Tilia* in our range do exhibit, in general, degrees of difference in their over-all pattern of characteristics, we are inclined to recognize but one variable complex, *T. americana*. It seems futile to attempt segregation into more taxa, certainly not without studies applying techniques and employing values other than those traditionally used. In northern Florida, *T. americana*, thus broadly interpreted, embraces a range of plants, some of which individually correspond to *T. heterophylla*, *T. floridana* [Small], *T. crenoserrata* [Sarg.], and *T. georgiana* [Sarg.]." With specific limits so uncertain, it seems to be most reasonable at the present time to follow Kurz and Godfrey in the recognition of a single variable species, *T. americana* L., *sensu lato*, $2n = 82$, both in our area

[3] Cf. E. L. Little, U. S. Dep. Agr. Agr. Handb. **41**: 417–421. 1953; Fernald, Gray's Man. Bot. ed. 8. 999. 1950; Gleason & Cronquist, Man. Vasc. Pl. NE. U. S. Canada 461. 1963; Steyermark, Fl. Missouri 1042–1044. 1963; Brown, 1945; Kurz & Godfrey, 1962.

and the entire United States. The taxonomy of the Mexican representatives needs to be considered in conjunction with this concept.

The European *Tilia cordata* Mill., $2n = 82$, and *T. platyphyllos* Scop., $2n = 82$, and the Eurasiatic *T. petiolaris* DC., $2n = 82$, introduced into the United States, are reported to spread sometimes from cultivation to waste places and roadsides in the Northeastern States.

The flowers are pollinated mainly by Hymenoptera, especially bees, and Diptera, the insects apparently being attracted, not only by the fragrance and often bright color of the flowers, but also by the large, yellow-green bract of the inflorescence. At least in European species wind-pollination also seems to be of importance (Eisenhut). Although proterandry and the relative positions of stigmata and anthers seem to prevent self-pollination in individual flowers, pollination from neighboring flowers of the same tree is said to occur side by side with cross-pollination. As Jordan (1886) showed, the nectaries are situated at the base of the adaxial surface of the sepals, not on the petals.

The vascular ground plan shows that the androecium of *Tilia* is diplostemonous, consisting at an early stage of development of five antisepalous double groups of stamens of the outer whorl and five antipetalous stamens of the inner whorl. "As development proceeds the double group of stamens in front of each sepal separates into two half groups, with the result that in fully developed flower the whole androecium consists of five antipetalous phalanges [fascicles], each phalange [fascicle] being composed of a single antipetalous member in the centre flanked by half the antisepalous group on each side" (Saunders). Only the five originally antipetalous stamens usually are modified into staminodia.

Chromosome counts (eleven species) are $2n = 82$ and 164, suggesting that the genus is highly polyploid. Although many spontaneous hybrids are known from cultivation, and much hybridization between wild plants has been supposed, only a single wild putative hybrid, *Tilia* × *vulgaris* Hayne (*T. cordata* × *T. platyphyllos* appears to have been reported. This fully fertile hybrid is said to form pure stands in Lithuania and the Ukraine (Jaccard & Frey).

The winglike bracts promote wind transportation of the infructescences; seeds are dispersed to a lesser degree by rain wash and by some frugivorous birds and mammals, especially rodents. Under natural conditions seeds germinate slowly and irregularly, sometimes remaining dormant for two to four years. Dormancy in *Tilia americana* is due to an impermeable seed coat and a partially dormant embryo.

At least on the basis of wood anatomy, the genus has been regarded as closely allied to the Indochinese-Indonesian *Schoutenia* Korth. and *Chartocalyx* Maing. ex Mast., but these two genera have pollen of a more or less malvaceous type and seem to occupy an isolated and uncertain position in the family. The pollen of *Tilia* appears to be closer to pollen of the genera of subfam. Brownlowioideae (Benth. & Hook.) Burret than to that of the genera of subfam. Tilioideae (Erdtman, Pollen Morphol. Pl. Taxon., 1952).

Tilia americana, sensu lato, and the European *T. cordata* and *T. platyphyllos* supply highly valuable, soft, white lumber of great utility; the inner bark is sometimes used for making cordage. These and some other European and Asiatic species are cultivated as ornamentals, all being also esteemed as honey plants. Flowers of *T. cordata*, *T. platyphyllos*, and *T.* × *vulgaris* Hayne (often referred to as *T. europaea* L.) are officinal, at least in Europe. Seeds are said to be a source of oil for cooking and other purposes.

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Tribe CORCHOREAE Burret

2. **Corchorus** Linnaeus, Sp. Pl. 1: 529. 1753; Gen. Pl. ed. 5. 234. 1754.

Annual or perennial herbs, woody at base, or subshrubs [shrubs], usually pubescent with simple [and/or stellate] hairs. Leaves alternate, small to medium sized, usually unlobed; stipules small, linear-filiform to filiform [or lanceolate], usually caducous. Flowers small, bisexual, short pediceled to subsessile, solitary and/or in umbel-like 2- or 3[–8]-flowered sessile to short-peduncled bracteate cymes opposite the leaves; bracts small, narrow, ± persistent. Sepals usually 5, distinct, sometimes cucullate, deciduous. Petals usually 5, distinct, yellow, spatulate to obovate, sometimes short clawed, shorter [or longer] than or equaling the sepals, convolute. Disc extrastaminal, annular to cuplike, or absent (in most American species). Stamens usually numerous (rarely [5–]8 or 10), appearing ± evenly distributed, ± distinct, sometimes on a short

androgynophore; anthers introrse, dorsifixed. Gynoecium 2- or 3[–5]-carpellate; stigma large, discoid [to subglobular?], irregularly dentate, crenulate to lobulate; style simple, subcylindrical to filiform, usually longer than the stamens, with a stylar canal; ovary sessile or rarely on a short, glandless androgynophore, ± cylindrical [or subglobular], 2- or 3[–5]-locular, usually ± pubescent; ovules numerous [to 2] in each locule, usually axile in two collateral rows, ± pendulous, anatropous, epitropous [or apotropous]. Fruit a loculicidal capsule, ± cylindrical, usually elongated and podlike [or ellipsoid to subglobular], terminating in a beak, short horns, or teeth, smooth [rarely with soft, spine-shaped excrescences], glabrous or ± pubescent with simple [or stellate] hairs, 2- or 3[–5]-locular [sometimes with incomplete transverse partitions between the seeds], 2- or 3[–5]-valved [or sometimes indehiscent]. Seeds usually numerous in each locule, irregularly 3- or 4-angled or disclike, usually with truncate ends, dark brown to black; seed coat coriaceous or crustaceous, the raphe fine, hardly noticeable, oblique, apparently lateral, the chalazal knot cushion-like; endosperm fleshy; embryo large, axial, "folded"; cotyledons foliaceous, entire; radicle superior. LECTOTYPE SPECIES: *C. olitorius* L.; see Britton & Millspaugh, Bahama Fl. 262. 1920. (Name from Greek, *korkhoros*, an ancient name for some herbaceous pot plant, perhaps *C. olitorius*; etymology obscure.)

A pantropical genus of about 40 species, centered in Africa (ca. 15 species) and Australia (ca. 15 species), with several in Asia and America. Two tropical American and one pantropical species occur in our area. The American species, except the pantropical *Corchorus aestuans* L. and the East African-West Indian *C. hirsutus* L., seem to differ from those of the Old World at least in an obsolete disc in the flowers.

Corchorus siliquosus L., $2n = 28$, is a subshrub or perennial herb, with leaves only 1–3 cm. long and slender, nearly cylindrical capsules 5–8 cm. long, bearing four minute toothlike appendages at the nearly truncate apex. Occurring almost throughout tropical America, it extends northward through the West Indies to hammocks, cultivated ground, and roadsides of the Florida Keys and southernmost peninsular Florida, where it seems to be indigenous. Records from Texas need verification. *Corchorus orinocensis* HBK., usually a sparingly branched annual or perennial with slender, subcylindrical, slightly flattened capsules 4–7 cm. long and attenuated into a straight beak, is widely distributed throughout tropical America and similarly reaches southernmost Florida (Dade and Monroe counties). It is also known from Mobile and Tuscaloosa counties, Alabama, southeastern Louisiana, and from scattered localities westward through southern Texas to southern Arizona and Mexico. The Alabama occurrences (and perhaps those in Louisiana) seem to be incidental introductions with subsequent naturalization (see R. M. Harper, Geol. Surv. Ala. Bull. **53**: 152. 1944). A third species, the widely distributed *C. aestuans* L. (*C. acutangulus* Lam.), $2n = 14$, is known as an adventive weed from at least Dade, Collier, Leon, and Escambia counties, Florida,

and Mobile County, Alabama. It is usually an annual, with bristle-like appendages on the lowermost pair of teeth of the leaves, a minute androgynophore bearing a disc at the apex, and stoutish, subcylindrical, 3(–6)-angular and narrowly 3-winged capsules 1.5–2 cm. long and terminated in three usually bifid horns.

At least the cultivated *Corchorus capsularis* L., $2n = 14$, and *C. olitorius* L., $2n = 14$, are short-day plants. The flowers of the two open respectively about an hour after and an hour before sunrise (Kundu). Cross-pollination by insects seems to be the rule, self-pollination apparently being prevented by the stigma's overtopping the stamens.

The inner, antisepalous whorl of stamens is completely suppressed, while the outer, antipetalous whorl is multiplied. The traces for the antipetalous stamens, which arise conjointly with those of the petals, divide primarily into three bundles: a median and two laterals. According to Rao, all three branch to form a large number of staminal bundles. The extrastaminal nectariferous disc (and sometimes an androgynophore) is present in the Old World species, but both seem to be absent (obsolete) in those indigenous to the New World. The stamens in a flower usually are distinct, appearing evenly distributed upon the receptacle, but sometimes a few groups of two to four stamens with filaments connate for various lengths can be observed. The anthers are dorsifixed (not basifixed, as stated by some authors) and are usually vertical and nearly straight. The orientation of the ovules should be investigated, since both epitropy and apotropy have been recorded by various authors.

Chromosome counts made for 12 species are $2n = 14$ and 28 (three species). Although no conclusions can be drawn, it is notable that two of the tetraploids are American and one is Australian, while all the diploids are either Asiatic or African. A trisomic mutant showing "dimorphic gametes" (microspores?) with $n = 7$ and 8, and an aberrant trisomic branch ($2n = 15$) of a normal diploid plant have been recorded in *Corchorus capsularis*. Hypo- and hyperploidy have also been detected in all Indian species of the genus. Numerous attempts to produce artificial interspecific hybrids, especially between *C. olitorius* and *C. capsularis*, have been unsuccessful with both diploids and induced tetraploids. In 1960, Islam and Rashid reported the first sucessful cross, *C. olitorius* ♀ × *C. capsularis* ♂, resulting in a few slow-growing, somewhat fertile hybrids. Chaudhuri and Jabbar Mia later published on successful crosses at the diploid level between *C. olitorius* and *C. capsularis* and the latter and *C. trilocularis*. These crosses resulted in vigorous and fertile hybrids, but *C. capsularis* ♀ × *C. trilocularis* ♂, on the tetraploid level, resulted in sterile hybrids. All crosses of *C. aestuans* with these species were unsuccessful.

The minute, very light seeds of *Corchorus* apparently can be distributed by wind (Islam & Khan), but the wide, even pantropical, distribution of some species seems to be due largely to casual introductions (e.g., in ballast).

The genus occupies an isolated position in the Tiliaceae, representing a tribe of its own. A revision of the genus is very desirable.

The Indo-Burmese *Corchorus capsularis* and the presumably African *C. olitorius* are important economic plants, the main source of the commercial fiber jute. Grown extensively in India and East Pakistan, and to a minor extent in the Philippines, Formosa, Brazil, and elsewhere, both often become naturalized. Leaves or young shoots of these and some other wild species are eaten as vegetables and/or used in folk medicine in many tropical countries. *Corchorus olitorius* has been cultivated as a pot herb in the eastern Mediterranean, particularly in Egypt, from ancient times. Seeds of *C. capsularis*, *C. olitorius*, and some other species are poisonous, containing glycosides of the *Digitalis* type.

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Tribe TRIUMFETTEAE Burret

3. **Triumfetta** Linnaeus, Sp. Pl. 1: 444. 1753; Gen. Pl. ed. 5. 203. 1754.

Annual or perennial herbs, ± woody at base, or subshrubs [deciduous shrubs or small trees], ± pubescent with simple and stellate [rarely peltate] hairs. Leaves alternate, undivided and/or palmately 3[–5]-lobed, a few teeth at base of blade usually modified into glands; stipules small, linear-lanceolate, subpersistent. Inflorescences [solitary or] fascicled, short-peduncled, bracteate few-flowered umbel-like cymes (dichasia), lateral to and/or opposite the leaves or leafy bracts and sometimes also terminal, often forming narrow, raceme-like, interrupted cymose panicles by reduction of leaves. Flowers distinctly pediceled, usually small, bisexual [sometimes also carpellate, the plants then polygamodioecious]. Sepals 5, distinct, narrow, ± flat or cucullate, abaxially ± pubescent with simple and stellate [rarely peltate] hairs and each with an abaxial subapical hornlike appendage. Petals 5 [or absent], distinct, yellow, narrow, equaling to shorter than sepals, with a transverse band of stellate hairs on the adaxial (interior) surface above the short claw and a thickened glandular (?) area at the base, imbricate. Androgynophore usually present, short, bearing 5 antipetalous glands on its surface and often a thinnish, ciliate extrastaminal disc at its apex. Stamens numerous to 5 [3], inserted at apex of androgynophore, distinct [staminodial or absent in ♀ flowers], usually shorter than the style; anthers introrse, elliptic in outline, dorsifixed. Gynoecium 2- or 3[–5]-carpellate; stigma minutely 2- or 3-lobed [or unlobed], the lobes short, filiform, spreading; style long, slender, solid; ovary 2- or 3[–5]-locular, densely covered with minute tubercles, each terminated in a hyaline incurved [or erect] spinule; ovules 2, collateral in each locule, pendulous from the top of axile placentae, anatropous, epitropous. Fruit indehiscent, nutlike [or dehiscent, capsular or schizocarpous?], small, globular or ovoid, 2- or 3[–5]-locular, sometimes appearing either 4- to 6[–10]-locular through development of false partitions between the seeds or 1-locular by reduction of one or more locules; surface covered with spreading or ± upright, subcylindric-subulate, rigid, [glabrous or]

FIG. 1. **Triumfetta.** a–g, *T. semitriloba:* a, upper part of stem in flower and fruit, × 1; b, flower (two sepals, one petal removed), showing short androgynophore with three of the five antipetalous glands, disc, stamens, and style with 3-lobed stigma, × 12; c, flower in semidiagrammatic vertical section (stamens removed), to show androgynophore with a gland, disc, and anatropous ovules (one in section) with obturator of hairs, × 40; d, fruit, × 6; e, fruit prickle, × 12; f, fruit in semidiagrammatic cross section, showing two 2-seeded locules and thin false partition between seeds in the third (lowermost), the cotyledons outlined in dots, the sclerified part of seed coat in black, × 8; g, seed with circular chalazal knot depressed in center, membranaceous outer layer of seed coat obliterated, × 16. h, *T. pentandra:* fruit prickle, × 12.

retrorsely hispidulous or plumosely pubescent prickles, each usually terminated by one [to several] stiff, clawlike [or ± straight] hyaline spinules. Seeds (1) 2–6[–10], ovoid [lenticular or subreniform?], with a fine, linear, adaxial raphe (usually obliterated on mature seeds) and a basal, circular, depressed chalazal knot; outer seed coat thin, membranaceous, the inner coriaceous to crustaceous; endosperm fleshy; embryo large, axial, straight, "spatulate," the cotyledons flat, ovate to suborbicular, the radicle superior. TYPE SPECIES: *T. Lappula* L. (Name commemorating Giovanni Battista Trionfetti, 1658–1708, professor of botany at the University and director of the Botanical Garden in Rome.)

A pantropical genus of over 100 species, apparently almost equally centered in tropical America and Africa, less abundant in Asia, Australia, and the Pacific Islands. At least four species, two naturalized in the southernmost part of our area, are of pantropical distribution. Sprague and Hutchinson recognized four sections based primarily on fruit characters. All American and most Old World species belong to sect. TRIUMFETTA (§ *Lappula* DC. em. Sprague & Hutch.).

Triumfetta semitriloba Jacq., $2n = 32$, occurs in cultivated ground, hammocks, and pinelands on the Florida Keys and in peninsular Florida, north at least to Manatee County, on the west coast, and Palm Beach County, on the east. It is a perennial herb or subshrub, with variable, generally ovate, unlobed to 3-lobed leaves; flowers with flat sepals, a well-developed disc, and 15–25 stamens; and nearly globular, subglabrous fruits with sparsely retrorsely hispidulous prickles. In contrast, *T. pentandra* A. Rich. is an annual or perennial herb with broadly ovate, unlobed to deeply 3-lobed leaves sparsely pubescent with simple and stellate hairs; flowers with cucullate sepals, a somewhat reduced to obsolete disc, and 5–8 (13) stamens; and subglobular-ovoid fruits with ± upright prickles plumosely pubescent on the adaxial side with straightish spreading hairs. It was collected in Sumter County, Florida, in 1900, but present status in our flora is uncertain.[4] Although apparently pantropical, the species seems to be most abundant in Africa and rather scattered and local elsewhere (Cape Verde Islands, Arabia, India, Ceylon, Formosa, Timor, and northeastern Brazil).

Cross-pollination by insects seems to be the rule, selfing apparently being prevented, at least in many species, by the position of the stigma

[4] Small (Man. p. 842. 1933) and Lay (p. 383) considered this species to be *Triumfetta rhomboidea* Jacq. (*T. Bartramia* L., nom. illeg.), $2n = 32$ and 48, a pantropical species rather common in tropical America. Their opinion, if based on the single collection cited by Lay, *Curtiss 6738* ("Found in great abundance [growing 5 or 6 feet high] in cultivated ground at Webster, Sumter Co., Florida. October 27, 1900"), is apparently the result of either misidentification or misinterpretation of the species involved. *Triumfetta pentandra* A. Rich., 1830 (*T. neglecta* Wight & Arn., 1834; *T. cuneata* Hochst. ex A. Rich., 1847; *T. Sampaioi* Monteiro, 1938), is very similar and closely related to *T. rhomboidea*, which differs mainly in the well-developed disc, (8) 10–15 stamens, and nearly globular fruits with spreading, glabrous or subglabrous prickles. The Curtiss collection is clearly *T. pentandra*.

above the stamens. Data on pollinators are scarce, but bees, little beetles, and flies are recorded for some Old World species. The flowers of *Triumfetta flavescens* A. Rich. open at about 3 P.M. [Ethiopia] and those of *T. macrophylla* K. Schum. toward evening [East Africa]. "It is probable that the flowers of other species of *Triumfetta* open late in the day" (Sprague and Hutchinson).

The inner, antisepalous whorl of stamens in the flowers is completely suppressed. The trace for each of the outer, antipetalous stamens arises conjointly with a petal trace and then divides into three bundles, a median and two laterals, as in *Corchorus*. However, in *Triumfetta*, the median bundle remains adnate to the petal trace and feeds only a "staminodial nectary." The laterals usually undergo a secondary branching in connection with the multiplication of the stamens, each lateral giving rise to traces to two or more stamens (Rao, 1952). Flowers with a low number of stamens have not been investigated.

An obturator, consisting of unicellular hairs, recorded by Rao & Rao for *Triumfetta rhomboidea*, is also present in *T. semitriloba*.

Chromosome counts have been made for three species ($2n = 32, 48$). Occurrence of both 32 and 48 in *Triumfetta rhomboidea* suggests that the basic chromosome number of the genus is 8, rather than 16 as suggested by counts of $2n = 32$.

Fruits in *Triumfetta* are either dehiscent and capsular to schizocarpous or indehiscent and nutlike at maturity, but often (perhaps always?) splitting and freeing the seeds as the pericarp and partitions decay. Precise data on fruit dehiscence seem to be lacking; both loculicidal dehiscence and splitting into carpels or cocci are mentioned by various authors. The clinging fruit of species of sect. TRIUMFETTA, with their hooked prickles, are dispersed by man and other animals. In the species with densely plumose-pubescent, bristle-like fruit prickles (sect. LASIOTHRIX Sprague & Hutch.), dissemination by wind may be assumed, while in some creeping, Indo-Pacific littoral species with fruits equipped with narrowly conical nonhooked prickles (sect. PORPA (Blume) Sprague & Hutch.), dispersal by sea on floating pumice and on drifting logs has been recorded. The pantropical distribution of some species seems to be due mainly to human agency.

The genus is closely related to *Heliocarpus* L., a tropical American genus centered in southern Mexico and Central America. A revision of the entire genus is desirable.

Some species (e.g., *Triumfetta rhomboidea*, *T. semitriloba*, *T. Lappula*, *T. cordifolia* A. Rich.) yield fibers used locally in tropical countries for cordage, as well as for many domestic purposes; fibers from *T. rhomboidea* are said to be of commercial value. Leaves of several species are used as vegetables and also find some application in folk medicine. *Triumfetta rhomboidea* is said by Wilczek to be a remedy for leprosy.

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80–85), HERLEMONT (pp. 88–95), KUKACHKA & REES (pp. 44, 45), LAKELA & CRAIGHEAD (p. 59), RAO (1952, pp. 181–183, 200, 202), RAO & RAO, ROBYNS (pp. 25–32), SCHUMANN (pp. 28, 29), SINGH (p. 75), WEIBEL (pp. 168, 169), and WILCZEK (pp. 46–72).

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ELAEOCARPACEAE A. P. de Candolle, Prodr. **1:** 519. 1824, "Elaeocarpeae," nom. cons.

(ELAEOCARPUS FAMILY)

Trees or shrubs, differing from Tiliaceae mainly in the absence of mucilage cavities and ducts (although mucilage cells occasionally occur in the epidermis of leaves), in the considerably smaller spheroid to prolate pollen, and in the more primitive wood structure. Additional distinguishing characters include the occurrence of opposite leaves in some or all species of some genera, the prevalence of valvate petals and apical dehiscence of the anthers, and the nearly regular occurrence of a nectariferous (extra- to intrastaminal) disc. TYPE GENUS: *Elaeocarpus* L.

A nearly pantropical family of about ten genera and 400 species, centered in Papuasia (five genera, ca. 190 species) and South America (five genera, ca. 70 species), with a few extensions into the South Temperate Zone; absent from continental Africa. The single species of *Muntingia* is becoming naturalized in southernmost Florida.

Similarities in floral structure with Tiliaceae suggest a like floral biology and pollination by insects. Data from floral anatomy and embryology are few. Recorded chromosome counts (two genera, seven species) are $2n = 24, 28, 30$, suggesting aneuploidy. The petiolar anatomy appears to be more complex than in Tiliaceae.

The family is closely related to and sometimes included in Tiliaceae, but evidence from anatomy and palynology seems to be in favor of retaining the Elaeocarpaceae as a separate family. A relationship to Flacourtiaceae-Prockieae has also been postulated by some authors.

Some species of a few genera yield tanbark or lumber of local importance. A few species of *Aristotelia* L'Hérit., *Crinodendron* Mol., and *Elaeocarpus* are grown as ornamentals in the southern part of our area and/or southern California.

REFERENCES:

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1. **Muntingia** Linnaeus. Sp. Pl. 1: 509. 1753; Gen. Pl. ed. 5. 225. 1754.

Shrubs to small trees pubescent with simple and stellate hairs and viscid articulated trichomes; nodes 3-lacunar. Leaves 2-ranked, membranaceous, 3-nerved at the very oblique semicordate base, with 3–5 veins on each side of the midrib, closely to remotely toothed, villous with stellate hairs and cobwebby beneath, short petioled, with a single ± lateral filiform stipule (the second wanting or rudimentary?). Flowers regular, 1.5–3 cm. in diameter, hypogynous, usually supra-axillary, long pediceled, either solitary or in sessile (or rarely short-peduncled) fascicles of 2 or 3, with 3 filiform bracts at base. Sepals 5(–7), ± lanceolate, caudate, the filiform tip almost equaling the blade, connate at the very base into an in-

conspicuous shallow saucer-like calyx tube, densely pubescent on both surfaces, valvate. Petals 5(–7), distinct, white (rarely pink), thin, obovate, short clawed, equaling the sepals, imbricate and ± crumpled in bud. Disc intrastaminal, annular, on the edge of the shallowly concave receptacle, bearing a ring of long, straight hairs on the exterior side near the margin. Stamens numerous, distinct, inserted at base and partly on the exterior surface of disc, half as long as the petals; filaments filiform; anthers elliptic in outline, shorter than the filaments, dorsifixed, versatile, introrse (latrorse), longitudinally dehiscent. Gynoecium 5–7-carpellate, syncarpous; stigma subsessile or sessile, subpyramidal, longitudinally 5–7-grooved and -ridged, with a sinuous stigmatic surface on each ridge; style very stout and short or wanting; ovary sessile or very short stalked, 5–7-locular, the locules becoming slitlike, pubescent, and confluent above the placentae; ovules very numerous, anatropous, epitropous, on 2 ± ovoid placentae pendulous from the axis at the top of each locule. Fruit a subglobular berry, ca. 1 cm. in diameter, red or yellow, appearing irregularly many-locular, sweet, edible. Seeds numerous, obovoid to ellipsoid, minute; seed coat crustaceous, the cells of outer epidermis mucilaginous; raphe indistinct, the chalazal knot apiculate; embryo axial, stout, straight, subcylindrical, the cotyledons small, semicircular in cross section, nearly equaling the thick superior radicle. TYPE SPECIES: *M. Calabura* L. (Name commemorating Abraham Munting, 1626–1683, professor of botany in Groningen, Nederland, and author of several botanical works.)

The single species, *Muntingia Calabura*, widely distributed in the West Indies and from southern Mexico to Peru, northern Argentina, and Brazil, has become established in pinelands and hammocks (e.g., Sisal Hammock) in Dade and Hendry counties, Florida. Its further spread seems likely, for the ability to reproduce vegetatively and a tendency to become weedy have been recorded for the species.

The solitary flowers or fascicles of two or three flowers which develop in a sequence are derivable from the simple, peduncled dichasia which are sometimes encountered in the species. The floral anatomy, in general, is similar to that in Tiliaceae and in *Elaeocarpus* (Rao). The lack of one stipule seems to be correlated with the absence of one stipular trace (Sensarma).

The taxonomic position of *Muntingia* is uncertain. The embryo development is of the Onagrad type, which seems to be otherwise unknown in the Malvales. The smaller pollen and the absence of mucilage cavities in the axis and leaves suggest that it should be retained in the Elaeocarpaceae. However, the microscopic structure of the wood differs from that of the other genera of Elaeocarpaceae, but is very similar to that in *Dicraspidia* Standl. and has many points in common with other Tiliaceae (Metcalfe & Chalk). The structure of the leaf and inner bark, resembling that in *Tilia* (cf. Dumont), also seems to indicate a closer relationship to Tiliaceae than to Elaeocarpaceae. The genus is undoubtedly closely related to the

monotypic *Dicraspidia* (*D. Donnell-Smithii* Standl.), which is known from Honduras, Costa Rica, Panama, and Colombia.[5]

Grown as an ornamental in many tropical and subtropical countries, *Muntingia Calabura* often becomes naturalized. Fibers from the inner bark are used locally for making cordage and in basketry.

REFERENCES:

Under family references see BACKER & BAKHUIZEN (pp. 400, 401), DUMONT (p. 186), LAKELA & CRAIGHEAD, METCALF & CHALK (pp. 263, 265), RAO, ROBYNS, and SCHUMANN (1897, p. 230).

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[5] After having established *Dicraspidia*, Standley (p. 228) wrote, "There is no doubt in the writer's mind, however, that the plant is closely related to the genus *Muntingia*, and that it should be referred, consequently, to the Elaeocarpaceae, or rather to Tiliaceae, if these families are to be combined. In general aspect, and in pubescence, leaf form, and gross appearance of the flower *Muntingia* and *Dicraspidia* are very similar, so much so that their relationship can scarcely be questioned." Metcalfe & Chalk (p. 265) noted the similarity of the two in wood structure, which is different from that of the rest of the Elaeocarpaceae. *Dicraspidia*, in turn, doubtless is closely related to the monotypic eastern Peruvian *Neotessmannia* Burret, the single member of Tiliaceae subfam. Neotessmannioideae. *Muntingia* with its hypogynous flowers, on the one hand, and *Dicraspidia* and *Neotessmannia* with epigynous flowers, on the other, agree in many characters, especially in the supra-axillary position of the flowers and peculiar stigmata not encountered elsewhere within the Malvales. The three seem to form a special line of evolution either within or parallel to Tiliaceae. That these genera are monotypic seems to indicate the antiquity of the group.

POLLEN OF DEGENERIA VITIENSIS

A. ORVILLE DAHL [1] AND JOHN R. ROWLEY [2]

SINCE THE ORIGINAL DESCRIPTION of the uncommon, monotypic genus *Degeneria* of the family Degeneriaceae by Bailey and Smith (1942), additional collections of flowering and fruiting material throughout its known range in Fiji have been made by Smith (1949). Swamy (1949), in his careful morphological analysis of the family, included a description of the microsporangium and microspores derived from Dr. Smith's collections.

This paper is a summary of additional observations made on microspore and pollen material utilizing primarily the techniques of phase contrast microscopy in association with electron microscopy.

MATERIALS AND METHODS

All observations were based on preparations made from specimens collected and preserved in Fiji by Dr. A. C. Smith. The field collections available for use were Dr. Smith's numbers *5744*, *5875*, and *5880*. The reagents used for fixation were limited to formalin-acetic acid-alcohol (FAA) and, in one instance, to potable spirit (gin). Despite the poor over-all state of preservation for purposes of electron microscopy, data on our preparations are reported in view of the present scarcity of material.

Microspores and mature intact pollen grains were mounted from the preservative into various media (cf. Bailey, 1960; Dahl, 1952). Precise, but impermanent, staining of pectic components of apertural membranes was attained by mounting the specimens in filtered 0.2% ruthenium red in 75% aqueous glycerine (Mangin, 1893; Bailey, 1960). The slides retained specificity of reaction for a period of up to ten days when stored in a refrigerator.

Material was mounted, either directly or after extracting procedures, in lactic acid (ca. 85%) or media based largely on this reagent (e.g., "lactic-iodine" made by combining 1 part of 1% iodine and 1% potassium iodide in 80% ethanol with 3 parts of lactic acid, or "lactic-triacetin"

[1] This work was supported in part by funds from the National Science Foundation (Grant G9973) and the National Institute of Allergy and Infectious Diseases, National Institutes of Health (Grant E3989). Grateful acknowledgment is made to Professor I. W. Bailey and Dr. A. C. Smith for preserved material of *Degeneria*. Professor Bailey generously provided research facilities during part of this study. In addition, Dr. Johs. Iversen kindly made research facilities available in his laboratory at Danmarks Geologiske Undersøgelse, Charlottenlund, Denmark.

[2] During early phases of this study, space and equipment were generously provided by Professor A. Frey-Wyssling and Professor K. Mühlethaler, Swiss Federal Institute of Technology, Zürich.

composed of 4 parts lactic acid and 1 part triacetin, or "lactic-butanol" prepared by combining 4 parts of lactic acid with 1 part of *n*-butanol). Such non-hardening media require sealing of the cover glass with a relatively inert varnish such as the phenolic "Tuf-On" #74 varnish (obtained from Brooklyn Paint & Varnish Co., Inc., 50 Jay St., Brooklyn 1, N.Y.). Preparations that did not require sealing were obtained by mounting the material in a variation of Downs' (1943) polyvinyl-lactophenol mixture designed to attain much of the favorable optical characteristics of lactic acid. This variation is made up of 3 parts lactic acid, 2 parts 15% aqueous polyvinyl alcohol (medium viscosity), and 1 part phenol.

Pollen grains badly darkened by the preserving fluid were partially cleared when mounted in 70% aqueous chloral hydrate. Such mounts were satisfactory for phase contrast analysis.

A desirable optical environment for purposes of phase contrast analysis of sections of methacrylate-embedded specimens with the embedding medium still present was maintained by mounting the sections in a drop of a 1:1 mixture of poppyseed oil and *n*-butanol followed by sealing of the cover glass. For ordinary microscopy, similar sections of methacrylate-embedded microspores were mounted in the lactic acid-iodine medium. After sealing, these preparations revealed the familiar yellow-stained cell walls and purple-stained starch grains in an optically suitable environment.

Pollen grains were treated with Novopokrowsky's (McLean & Cook, 1952) chloroiodide of zinc for observation of apertural structures.

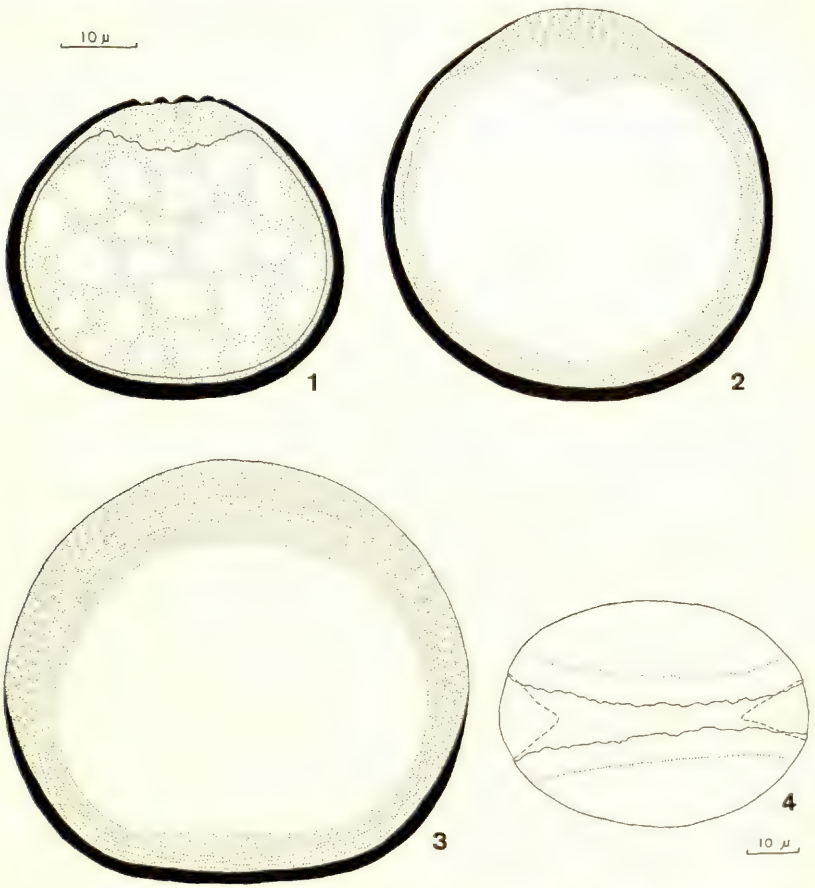
Microscopical observations were made with apochromatic (Leitz, N.A. 1.32) and fluorite phase (Leitz, N.A. 1.15 and Wild, N.A. 1.30) objectives.

Electron microscope preparations were obtained from osmium tetroxide, potassium permanganate, and uranyl acetate-stained materials (Pease, 1960) embedded in methacrylate or the polyester copolymer "Vestopal W" (Ryter & Kellenberger, 1958).

OBSERVATIONS

Microspore Stages. During the quartet stage of telophase II of meiosis, a callose wall up to ca. 2.5 μ in thickness bounded each group of microspore protoplasts. The early microspores in the available quartet stages did not have an exine.

The youngest available microspores (Fig. 1) bounded by exine were at a pre-mitosis stage. The exine was fully developed and continuous over the entire microspore surface. The outer surface of the exine was smooth while the inner surface was fimbrillate (Figs. 5–7). An incipient aperture was differentiated but not expanded. In thin sections, the exine was found to taper gradually in thickness as it extended from proximal regions of the pollen grain to the apertural margin where exine of minimal thickness occurred (Fig. 5). Over the incipient germinal aperture, the exine was undulate and was 3 to 5 times thinner than in nonapertural regions (Figs. 8 & 9). Intact microspores at this stage were about 40 to 44 μ in diameter with a perimeter of 125 to 135 μ (Fig. 1).



FIGS. 1–4. In FIGURES 1 to 3 the dimensions and form of the components of these composite drawings were obtained from camera lucida drawings and electron micrographs. Magnification, as reproduced × ½, ca. 1,100. 1, *Degeneria vitiensis* microspore prior to microspore mitosis. Cross section through the unexpanded aperture. 2, Cross section through mature pollen of *Degeneria*. 3, Longitudinal medial section through aperture of mature pollen of *Degeneria*. 4, Camera lucida drawing of whole mount of a *Degeneria* pollen grain with the distal pole uppermost showing margin of the aperture. Magnification, × ½, ca. 750.

There was an intine-like, low density layer 0.4 to 0.05 μ in thickness under the nonapertural exine. At the aperture, the intine-like material took the form of a thick, lens-shaped layer which showed localized dense channels or pockets of material (FIG. 8). This layer was rapidly and differentially stained with ruthenium red precisely as was the case in the apertural intine of the mature pollen grains.

In addition to the well defined exine and a translucent intine-like layer

there were several dense lamellae between the exine and the presumed intine (FIGS. 6 & 9).

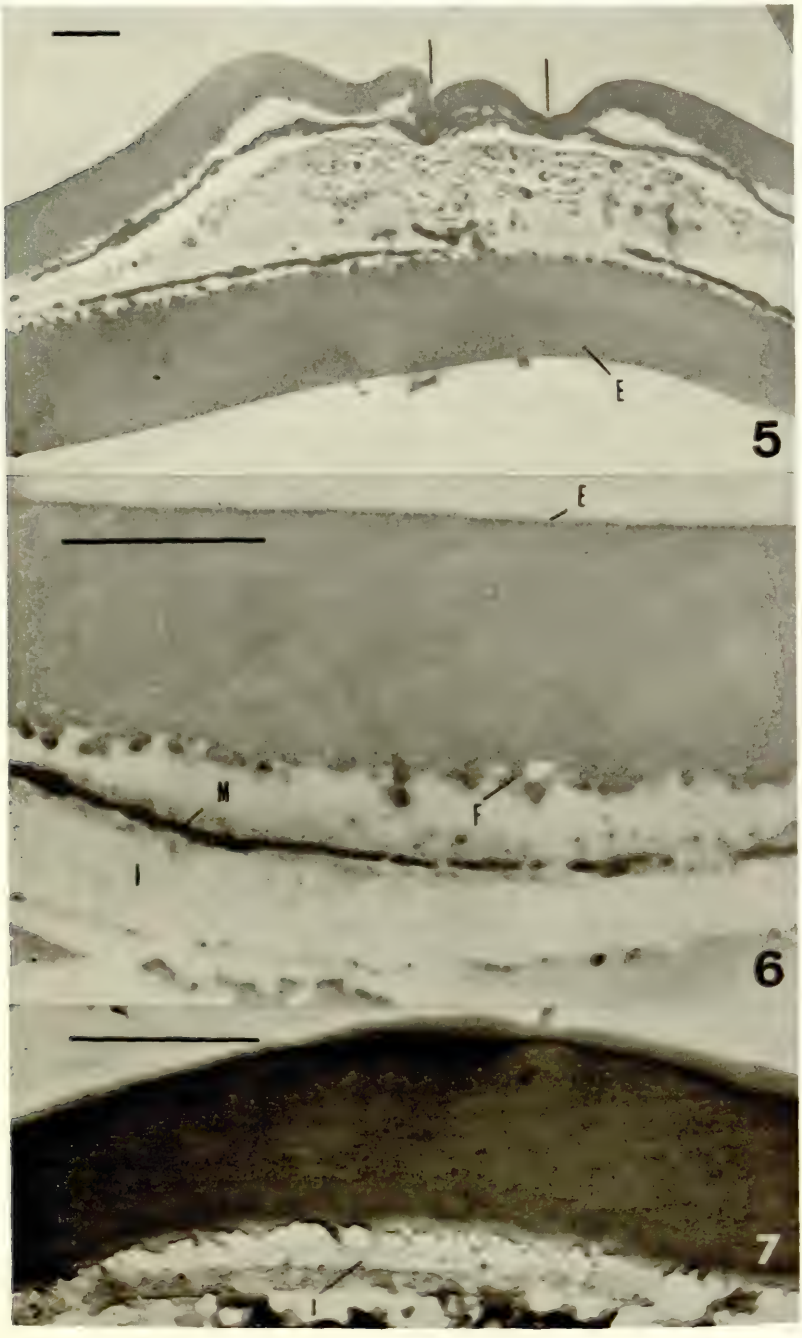
Mature Pollen Grain. The germinal aperture formed the only differentiated feature of the psilate pollen grain. The aperture extended over the distal surface to a point below the equator. At the distal pole, the aperture was usually constricted while its ends were enlarged (FIG. 4). A distinct but irregular exine margin was visible at an upper focal level with phase contrast microscopy. At a lower focal plane, a well delimited layer broader than the exinous opening ran the length of the furrow. This was made conspicuous with the ruthenium red reagent. In surface view, the layer appeared foveate, whereas in optical section it presented a columellate or striate appearance (FIGS. 10 & 11).

The aperture of pollen treated with Novopokrowsky's chloroiodide of zinc for ca. 30 minutes was striking in its greenish color and clearly revealed in the Zwischenkörper relatively fine structure having a striate appearance. In equatorial views of such pollen grains, the generative cell was usually close to the proximal pole, whereas the tube nucleus, while adjacent, was closer to the distal pole. The generative cell is about 12 μ in diameter with a nucleus 6.7 μ in diameter and a relatively inconspicuous nucleolus approximately 1.6 μ in diameter. In contrast, the tube nucleus is approximately 10 μ in diameter having a relatively conspicuous nucleolus some 5 μ in diameter.

We obtained positive reactions for cellulose in a thin layer bounding the protoplast but with the available specimens the microchemical tests were frequently imprecise and difficult to interpret. With Novopokrowsky's iodine-zinc chloride treatment a greenish coloration appeared, while a slight bluish-green reaction occurred in the intine when iodine-potassium iodide followed by 65% sulphuric acid were used. After bleaching with 30% H_2O_2 some of the pollen grains badly darkened by long storage in fixative gave, with the IKI-H_2SO_4 procedure, a purplish reaction possibly suggestive of cellulose at the surface of the protoplast. In unfixed pollen of *Liriodendron*, these procedures resulted in the typical blue cellulosic reaction in the inner intine of many grains. Bailey (1960), Martens and Waterkeyn (1962), et al. have reported the characteristic presence of cellulose in inner intine in a wide range of taxa including Magnolian and Ranalian species. Final decision on its occurrence in *Degeneria* can best be made with additional observations on fresh material.

In electron micrographs of pollen stained with osmium tetroxide and embedded in methacrylate, the intine was seen to be composed of two zones (FIGS. 2 & 15). The inner zone was comparatively uniform in texture. Near the terminus of the aperture this zone had an internal thickening or bulge (FIGS. 12 & 15). In nonapertural regions, the outer zone consisted of strands which graded into material of spongy appearance in the apertural part of the pollen grain (FIG. 15).

The appearance of the intine of pollen grains embedded in "Vestopal" following staining with osmium tetroxide, uranyl acetate or potassium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permanganate differed from the above in lacking a stranded inner zone (FIGS. 14 & 17). Analysis of sections before and after removal of embedding matrix and shadowing showed that the spongy part of the intine was composed of ramifying channels within the outer subdivision of the intine (FIGS. 15 & 16). In sections, the channels contained a dense substance (FIG. 17). Such channels were also visible in electron micrographs and phase contrast photomicrographs of the germinal aperture in *Liriodendron* pollen fixed in osmium tetroxide or potassium permanganate (FIGS. 18–21).

In the early formation of the apertural intine of *Liriodendron*, strands of microspore cytoplasm penetrated directly into the spongy structure (FIG. 18). Elements of the endoplasmic reticulum were seen to extend into the channels (FIG. 19). The inner zone of the intine was introduced at a later stage of development (FIGS. 20 & 21).

During maturation of the aperture in the pollen grain, cytoplasmic strands crossed the inner zone of the apertural intine and connected with the substance in the channels of the outer zone (FIGS. 20 & 21). When *Liriodendron* pollen reached maturity the channels still contained dense material, but connections with the cytoplasm through the inner part of the intine did not persist. Sections of *Liriodendron*, used for phase contrast microscopy, showed continuity of the material within channels of the intine and the cytoplasm (FIG. 13).

In sections of *Degeneria* anthers, small round bodies (0.44 to 0.55 μ in diameter) having a density the same as the exine, some with an eccentric cavity, were seen between the locule wall and the pollen wall (FIG. 15).

DISCUSSION

In its complex of pollen characters, *Degeneria* has natural alliance with Magnolian taxa (Bailey and Smith, 1942; Swamy, 1949). The single distal aperture is a familiar basic character. The following distinguishing characters were observed in pollen of *Degeneria*: a narrow furrow extending over the distal hemisphere and ending somewhat below the equator in

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(NOTE: beginning with FIGURE 5, the black scale line on the electron micrographs is equal to one micron.)

FIGS. 5–7. 5, Electron micrograph of *Degeneria vitiensis* microspore fixed in Fiji by histological methods. Exine tapering gradually in thickness toward differentiated but unexpanded apertural region (between lines). Microspore is collapsed so a portion of exine of proximal surface (E) is near aperture. Exine of proximal surface may be 15 times thickness of exine of apertural region. Magnification ca. 9,000. 6, Electron micrograph of nonapertural exine of a *Degeneria* microspore. Outer surface of exine (E) smooth, inner surface (F) fimbrillate; dense material (M) of a seemingly laminate nature between exine and intine (I), remnant of cytoplasm below the intine. Magnification ca. 28,000. 7, Section of *Degeneria* pollen exine similar to FIGURE 6, but with embedding material removed and section shadowed with chromium. Fimbrillae of inner surface of exine seen against intine (I) which has become separated from exine. Magnification ca. 26,000.

FIGS. 8–11. 8, Electron micrograph of *Degeneria* microspore. Exine at

the proximal hemisphere; a dumbbell-shaped aperture caused by an increase in the width of the furrow in the equatorial region; an extremely thin exine covering the distal surface with the exception of the narrow aperture; and a smooth and internally amorphous exine even at magnifications of the order of 30,000 times. Many pollen types described as psilate are found to be ornamented as improved methods of observation can be applied, but *Degeneria* offers an example of an exine that is truly psilate.

The remarkable sponge-like apertural structure (*Zwischenkörper*, Fritzsche, 1837) of *Degeneria* pollen is portrayed in the electron micrographs used for FIGURES 15, 16, and 17. The channeled Zwischenkörper of *Degeneria* microspores and pollen grains is similar to apertural structures observed in *Liriodendron tulipifera* (FIG. 20). In *Liriodendron* preparations it is clear that the channels which are isolated in the Zwischenkörper in mature pollen were part of a system of cytoplasmic strands connecting the wall with peripheral cytoplasm of the microspore during early stages of development (FIGS. 13 & 18). As in *Liriodendron*, the Zwischenkörper of *Degeneria* was quickly responsive to specific ruthenium red staining. In microspores and mature pollen of both genera the ruthenium red reagent sharply differentiated the Zwischenkörper as a channeled ribbon-like structure. The red-violet ruthenium red coloration usually first appeared in equatorial regions of the germinal furrow, and the color was deeper there than in the distal region. Presumably, areas of intense coloration following ruthenium red staining were loci of high polyuronide concentrations (Bailey, 1960) and were related to the system of cytoplasmic strands. In Dr. A. C. Smith's collection No. *5880* we found grains with pollen tubes in various stages of emergence. Pollen tubes were also reported for this material by Swamy (1949). The pollen tubes we saw had gained exit at the ends of the germinal furrow in the region giving the most intense reaction to ruthenium red. The exine bounding the apertural area tapered to a thinness of 10–50 millimicra over the Zwischenkörper (FIG. 15) and was difficult to separate from the Zwischenkörper in our electron micrographs (FIG. 16). Evidence for an exine-like covering over the distal surface comes from LO analysis of intact pollen and the resistance of material in that part of the wall to acetolysis. In mature grains stained with potassium permanganate, the exine seemed to

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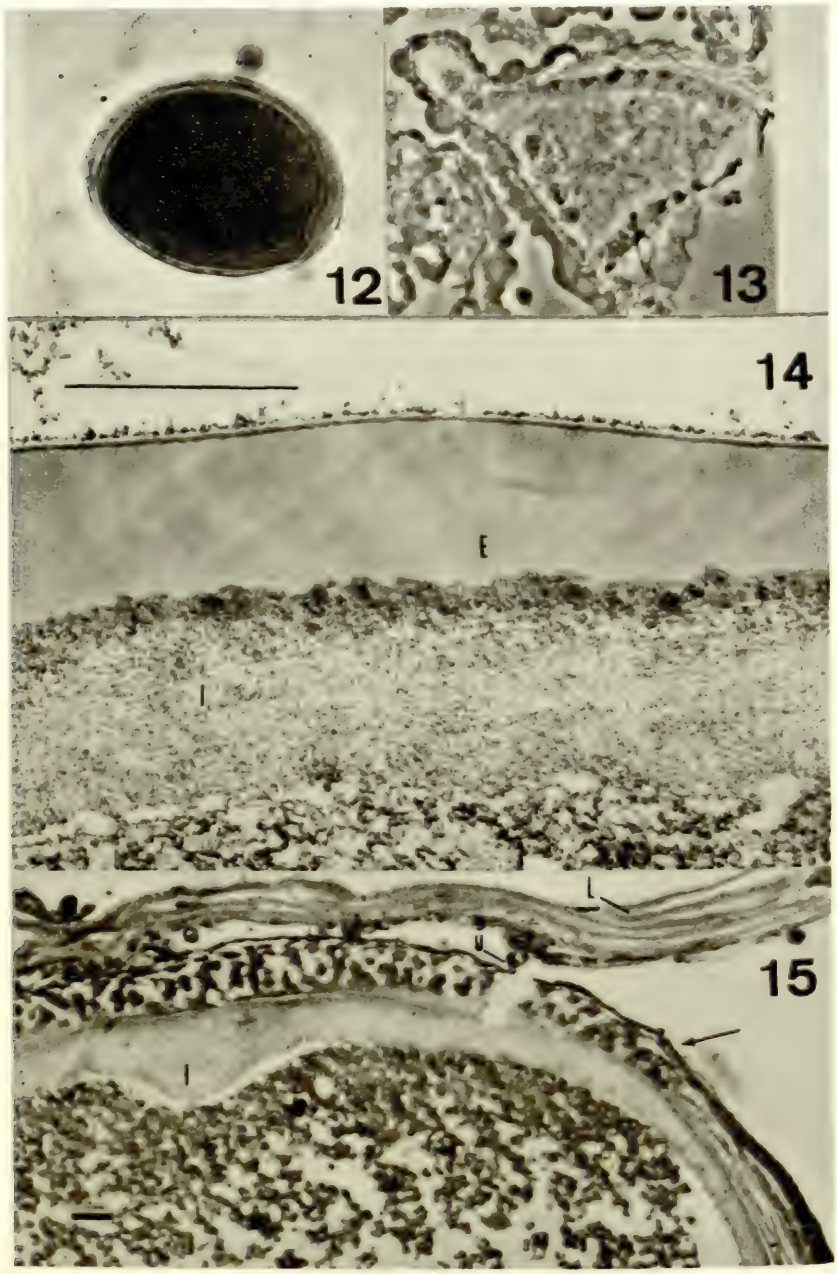
presumptive aperture (A) is differentiated into a thin and folded form, but there is no opening; intine is lens shaped in apertural region and considerably thicker than elsewhere; localized pockets of dense material (arrow) may be seen in intine. Magnification ca. 11,000. 9. Similar to FIGURE 8 except for thickening (arrow) which is part of folded preapertural exine (thickenings of this nature seen at aperture margin in mature pollen). Dense lamellae (M) may be seen between exine and intine. Magnification ca. 20,000. 10. *Degeneria* (*Smith 5744*). FAA fixation; chloral hydrate mounting medium; phase contrast; upper focal plane at level of apertural margin. Lens-shaped *Zwischenkörper* appearing foveate in surface view and striate in optical section. Magnification ca. 1,400. 11, Same pollen grain as in FIGURE 10, except lower focal plane at level of channeled *Zwischenkörper*; phase contrast. Magnification ca. 1,400.



FIGS. 12–15. 12. *Degeneria* (*Smith 5744*). FAA fixation; lactic acid mounting medium; without phase contrast; optical, almost median, section of distal aperture. Magnification ca. 1,400. 13. *Liriodendron tulipifera* (Univ. of Minnesota Bot. Garden); fixation 57 (6–8)–22 RS #4; ultra thin section mounted

terminate near the limits of the Zwischenkörper while the dense material between the exine and intine continued out over the intine. The lateral extent of the apertural area and Zwischenkörper is not apparent in FIGURE 17 because the aperture is not fully expanded, but the figure illustrates the above relationships of the homogeneous exine, intine, and dense middle material.

Exclusive of the thin exine-like material over the Zwischenkörper, the area of the exine is only slightly greater for mature pollen than for microspores. Accommodation for the increased surface area demanded by the greater volume of the protoplast of mature pollen, as shown in FIGURES 1 and 2, seems to reside in the thin cover over the Zwischenkörper and the expanded ends of the aperture. The thin exinous covering of the apertural region must originate either by stretching of existing exine (perhaps the folded covering seen in presumptive apertures of microspores in FIGURE 8) or by proliferation from new sporopollenin between the microspore and mature pollen stages.

For *Degeneria* there is little evidence for deciding between the alternatives, stretching of existing exine or deposition of new sporopollenin. The fimbrillae of the inner exine surface change slightly in form from the microspore stage to mature pollen (FIGS. 6 & 14), tending to be more widely spaced and shorter in the mature exine. This phenomenon could be used with equal justification to argue for expansion of the entire exine cover or addition of new sporopollenin. Addition of at least some new sporopollenin to the exine following attainment of exine final form, prior to microspore mitosis, was reported for pollen of *Poa annua* (Rowley, 1962). But evidence is also available to support modifications in exine form by expansion of the exine. Kuprianova (1948) proposed that the differences in pollen size and shape in the Commelinaceae were largely the product of variation in the amount of expansion of the apertural part of the grains. In mature grains of *Pollia*, *Floscopa*, and *Commelina*, Kuprianova's illustrations suggest expansion of apertural ornamentations from a system like the nonapertural part of these pollen grains. In *Commelinantia anomala*, where conditions for determining the stage of development and fixation were more satisfactory than for *Degeneria*, we have made some deductions

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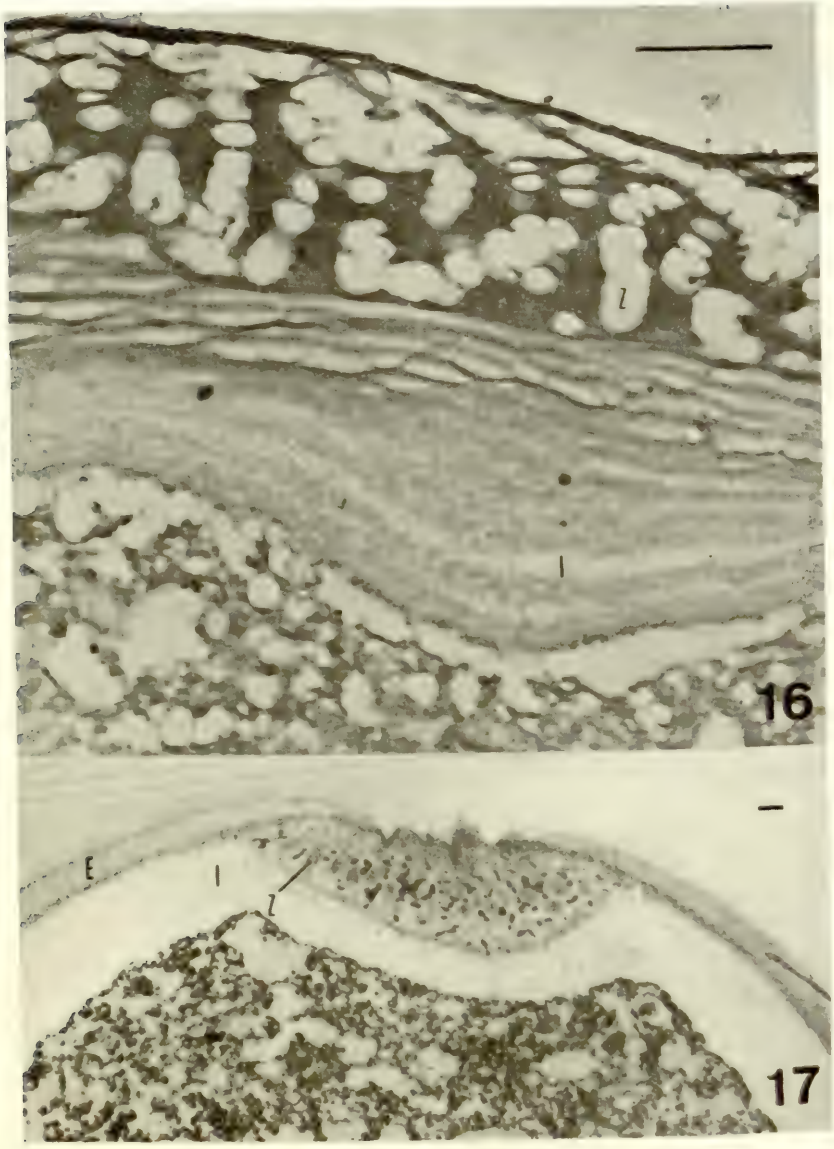
in 1:1 poppyseed oil-butanol; phase contrast. Lines in intine perpendicular to pollen protoplast are channels containing cytoplasm. Magnification ca. 1,800. 14. Electron micrograph of nonapertural part of mature exine of *Degeneria* pollen. A zone of dense material is between the exine (E) and intine (I); outer surface of exine is smooth, inner surface undulate to fimbrillate. Fimbrillae of mature exine less closely spaced than at microspore stage (cf. FIGURES 6 and 7). Magnification ca. 31,000. 15. Electron micrograph of section made perpendicular to aperture in mature *Degeneria* pollen grain. Exine tapering to thinness of 10 to 50 millimicra over aperture (arrow indicates right margin of aperture), intine with two zones, the inner comparatively uniform but with internal thickening (I) oriented parallel with aperture in the equatorial region; the outer part of intine constructed of strands (lower right) which join the spongy material at aperture margin; small round bodies (U), some with central cavity, located between locule wall (L) and pollen grain. Magnification ca. 5,000.



FIGS. 16 and 17. 16, *Degeneria*, the same material as in FIGURE 15 following removal of the methacrylate and shadowing with palladium. Internal thickening of inner part of intine at the lower right (I); spongy intine subdivision (Z), over inner intine, is composed of ramifying channels. If there is an exinous covering it must be on the order of 10 millimicra in thickness. Magnification ca. 18,000. 17, Electron micrograph of section of mature *Degeneria* grain cut across narrow part of aperture, at distal pole. In this $KMnO_4$-stained material, dense material between exine (E) and intine (I) extends out over the *Zwischenkörper* (Z). Channels in *Zwischenkörper* contain dense substance. Magnification ca. 3,500.

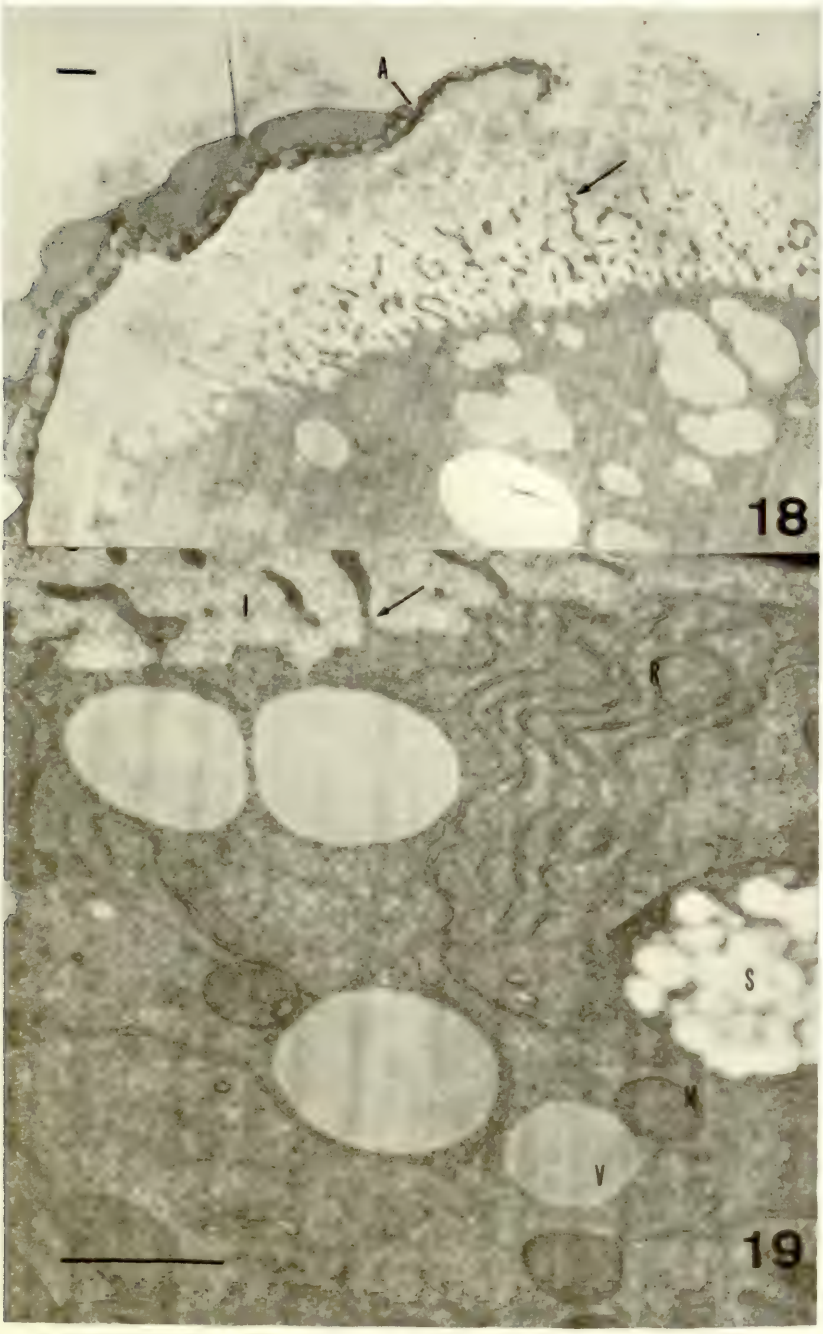
which parallel Kuprianova's suggestions and may be partially applicable to formation of the thin exine bordering the *Degeneria* aperture (Rowley & Dahl, 1962). In *C. anomala*, insulae bisected by the aperture margin had the appearance of apertural insulae at one end and nonapertural insulae at the other with indications of deformation by stretching in the middle regions. The endexine was reduced in height in the middle region from about 500 to 50 millimicra, concomitantly going from a sheet to a network, and the tegillar ends of columellae were tilted toward the aperture. We feel that these effects could be produced by movement of the apertural ends of insulae bisected by the aperture margin toward the aperture. The proximal ends of columellae around the periphery of apertural insulae splay outward and augment the notion that tension could be responsible for the tilting of columellae and conversion of endexine from a sheet to net form.

It may seem self evident that new sporopollenin would be added throughout the period of exine enlargement, but there are observations which suggest that the addition of new exine material is either stopped or does not keep pace with the area increase required by volume changes in the pollen protoplast during final maturation. In work with pollen of the Amaranthaceae Kajale (1940), for example, noted that the exine in mature grains was thinner than in earlier stages apparently due to its being stretched by protoplast growth.

Round bodies were seen in *Degeneria* anthers between the tapetum or locular wall and the male gametophyte in quartet, microspore, and mature pollen stages. These bodies frequently had central or eccentric openings of low density which in mature stages were found to be empty cavities after removal of the embedding material and shadowing with heavy metals. These exine-like bodies are similar to the tapetal secretion droplets, orbicules, or Ubisch bodies described or reviewed by Maheshwari (1950), Erdtman, et al. (1961), Heslop-Harrison (1962), Takats (1962), and Rowley (1963). In *Degeneria,* these orbicule-like bodies exhibit the psilate surfaces characteristic of the mature exine. It appears possible that some association exists between orbicules and the mature exine in the character of the ornamentation of the respective surfaces.

SUMMARY

Based upon material fixed by Dr. A. C. Smith in Fiji, the mature pollen wall of *Degeneria vitiensis* I. W. Bailey & A. C. Smith is psilate and tapers gradually from the proximal surface to a thin edge in the apertural region. The exine is internally amorphous. The inner surface is not smooth like the outer but fimbrillate. The intine is subdivided into an extensive lens-shaped Zwischenkörper, an outer part limited to the apertural region, and an inner part that envelops the cytoplasm and has but one distinguishing feature, a longitudinally oriented bulge parallel with the aperture and protruding into the cytoplasm. Ramifying channels in the Zwischenkörper contain a dense material. Several photomicrographs and electron micro-



FIGS. 18 and 19. 18. Electron micrograph of *Liriodendron tulipifera* micro-

graphs of pollen of *Liriodendron tulipifera* are included to demonstrate continuity of the dense material in the Zwischenkörper with the pollen cytoplasm in that species.

Quartet and late microspore stages are compared with mature pollen grains of *Degeneria* to suggest the mode of aperture differentiation and sequence of formation of the intine subdivisions. A dense material was seen between the homogeneous exine and the intine in both late microspores and mature pollen. Round exine-like bodies seen between the wall of the pollen grain and the tapetum or locule wall may be orbicules.

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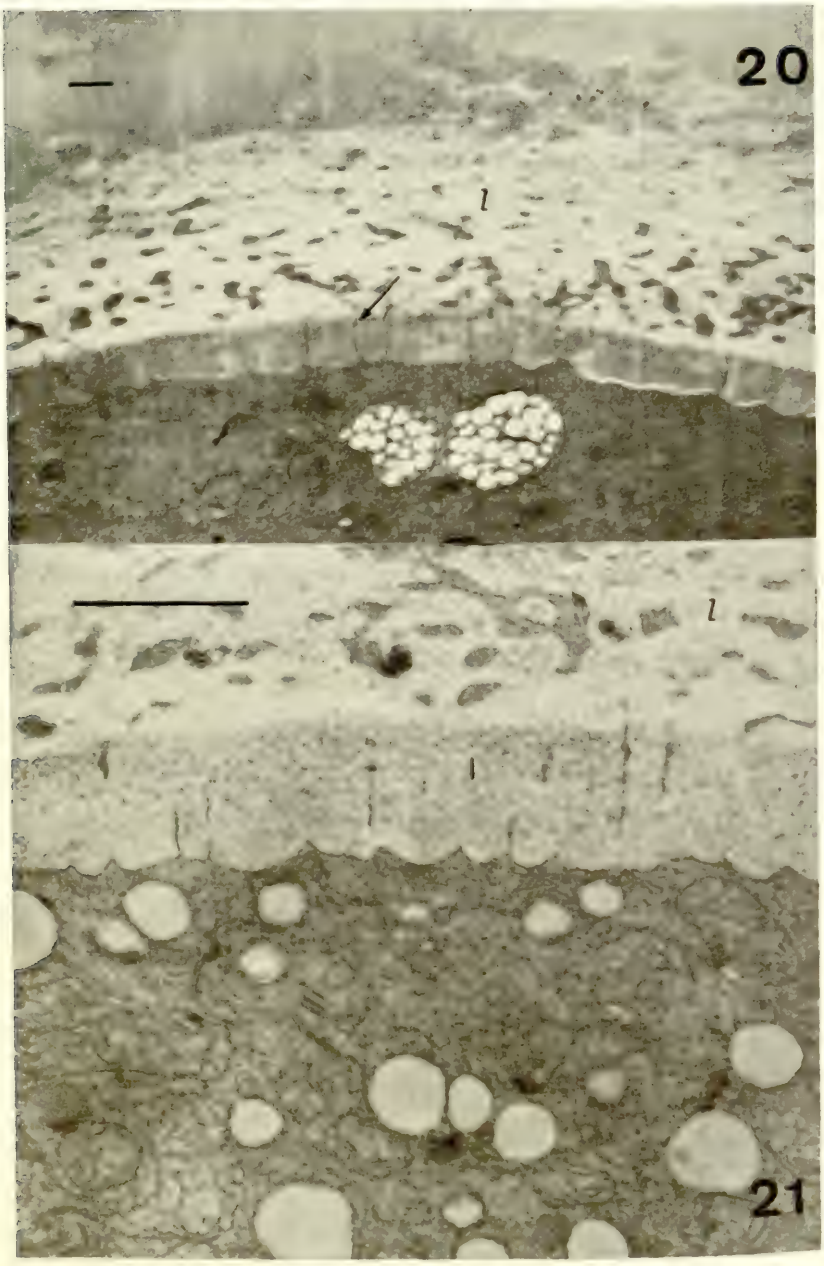
spore fixed in $KMnO_4$ and embedded in "Vestopal-W." Intine greatly thickened in region of aperture (aperture margin, A); early localization of cytoplasmic strands near protoplast occurred, although dense inner part of intine forms following microspore mitosis (see FIGURE 20). Magnification ca. 5,000. 19. Electron micrograph of *L. tulipifera* microspore at stage similar to material in FIGURE 18. Detail of junction between intine (I) and microspore cytoplasm; elements of endoplasmic reticulum (R) passing into cytoplasmic strands of intine (arrow); labeled cytoplasmic organelles are mitochondrion (M), vacuole (V), and starch grains (S) in a plastid. Magnification ca. 22,000.



FIGS. 20 and 21. 20, Electron micrograph of nearly mature pollen of *Liriodendron tulipifera*. Thick section showing cytoplasmic connections across inner part of intine (arrow) with cytoplasmic areas in the *Zwischenkörper* (Z). An inner zone of greater density to electrons developing in the intine near maturity

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of the pollen grain. Magnification ca. 6.000. 21. Electron micrograph from a thin section of the grain shown in figure 20. Figure includes some of tube nucleus cytoplasm at bottom, dense inner part of intine across center (I), and part of outer portion of intine of the aperture at top (Z). Magnification ca. 24,000.

LETTERS FROM CHARLES SPRAGUE SARGENT TO REGINALD SOMERS COCKS, 1908–1926 *

Edited by JOSEPH EWAN

147

June 26, 1917.

It is a long time since I have had any word from you. I hope you have not, like most of the rest of the world, given yourself up to raising potatoes and cabbages. There is too much botany left to be finished in Louisiana for that. I shall be glad to hear what you have seen and accomplished since you last wrote.

148

June 29, 1917.

The enclosed memorandum,[13] which do not return, may be of service to you.

I do not understand why we overlooked this tree when we were at Hammond, but I suppose we were busy thinking of other things.

How about the small Live Oak which we saw there on the prairies? I hope you won't fail to get the fruit.

149

July 18, 1917.

It is such a long time since I have had any word from you that I am beginning to be anxious about you. I hope you are not sick or otherwise incapacitated. Won't you drop me a line?

150

August 22, 1917.

Glad to get your letter even if it is written from such a place as Berlin.[14] I am glad that you will undertake the Opelousas and Springfield Oaks and I am counting on you to do this. I hope you will get specimens of the Oak with rhomboidal leaves.

You say that I have flowers of the Lake Charles Linden, but I haven't flowers, only young buds, of the Linden of which I need material, that is the tree at the ferry in West Lake Charles. If you have ever collected flowers of this I hope you will let me have them. This you know is the tree which has puzzled us a good deal and which we thought last spring was different from any of the other Louisiana Lindens.

* Continued from volume 46, p. 159.

[13] Enclosure missing.

[14] 2 mi. s. of Sardis, Dallas Co., Alabama.

Is there any chance of your being north this summer?

P.S. — Do you remember that *Carya alba*-like tree by roadside near Loringer with slender branchlets and very tomentose young leaves? I judge that the Winnfield tree which has so long bothered us is the same and I have specimens of what I take to be the same thing from Natchez. This is a tree which needs investigation. It may be only a variety of *alba* but it is unusual and we need mature leaves and fruit.

151

August 27, 1917.

I have yours of the 23rd and the specimen of *Quercus*, for which many thanks. This is not a straight *rhombifolia* but may be a form of it with lobed leaves. Notice the long-stalked fruit. I hope you will get specimens later and if possible find more trees.

There are no end of forms apparently of these southern Oaks. What should you think of the proposition of referring everything from Louisiana which has been called *laurifolia* to forms of *Q. nigra?*

152

October 27, 1917.

I am delighted with your bundle of specimens. The leaves of *Quercus geminata* are much thicker and more prominently veined than those of *Q. virginiana*. The Louisiana Live Oak is like the type as known to Catesby, Linnaeus, etc.

Quercus geminata, which is described as a small tree, by Small, is at Biloxi a large tree, as large as the common Live Oak with which it grows. It often has solitary fruit just as the typical Live Oak has the fruit in pairs, in threes or in fours in spite of anything Sargent's Manual may say. *Quercus virginiana* and *Q. geminata* seem to run together and I am going to consider the latter a form of the former. Small and Britton evidently got the two a good deal mixed up. I have not seen *Quercus geminata* from Louisiana or Texas.

We have no specimens of *Q. myrtifolia* from Louisiana and it should be dropped from the state unless we can get some real evidence of its occurrence there. The Chandeleur Islands are where it might be expected. Do you know anything of these Islands? I regret to say that we have no specimen from the Islands in Mississippi Sound on which this plant is reported to be very common. How can one be obtained?

Is your *Quercus* No. 4334 from Opelousas one of the trees with scaly bark in the low ground near Washington? This number seems to be the only one which has fruit. It may be hard to distinguish this specifically from the Post Oak, but it is evidently a distinct variety and a very fine tree.

Quercus No. 4716 near Hammond, Sargent and Cocks, in the spring. Is this from the small tree on the prairies with pale bark and slender drooping branches? If so, it seems to be an undescribed and interesting form of the Live Oak. Your small shrubs seem to be the same, so I suppose it is both a tree and a shrub.

I am glad to get the acorns of *Q. repanda*. I suppose it is undoubtedly a form of the White Oak, although the acorns do not look much like white acorns.

I should think now that we had Louisiana trees pretty well cleared up with the exception of *Crataegus* and the thin-branched, small-budded form of *Carya alba*. Have you been able to do anything about that? It grows near Hammond and at Wakefield near the quarry. I wish I knew more about this tree. I suppose you will have sometime specimens of *Carya pallida* from near Alexandria for me.

I hope your health is restored and that you have at last partially recovered from the shock of living in a town called Berlin. Did you come north this summer at all?

153

November 9, 1917.

Glad to get your letter of October 31st with information about the Oaks.

In regard to the Washington Oak I do not think it can be a hybrid, at least I can see nothing of *Quercus alba* in it. *Quercus Margaretta* is nothing but a Post Oak with the lobes of the leaves rounded at the ends. Such leaves with rounded lobes and others with the ordinary square lobes occur on the same tree and often on the same branch.

The dwarf Post Oak from Selma I want to call forma *stolonifera* of *Q. stellata*. The Hammond 4716 is certainly a very distinct form of *Q. virginiana* and might almost be called a species.

The Oak with rhombic leaves I have described as *Q. nigra* var. *rhombifolia*. I am not sure, however, after seeing your Alabama specimens if it should not be called a species. It certainly has more to do with *nigra* than with the Laurel Oak which has smaller, much thicker leaves which become much lobed on vigorous young shoots. My idea now is that the Laurel Oak does not get into Louisiana.

I have n't been to look at the Lindens yet. I want to wait until the whole season's collecting is in before tackling the annual job. I was in hopes I was going to finish it this year, but there is certainly an undescribed Linden near Raleigh, North Carolina, and apparently another at Charleston. Certainly there is no end to them.

154

November 27, 1917.

I do not know what to say about your hybrid Selma Oak. If *Quercus imbricaria* occurred in that region I should guess that it was one of the parents, but we have no indication here that *Q. imbricaria* reaches Alabama at all. My guess would be that *Q. marilandica* is one parent and the other may be *nigra*. Such determinations of hybrids, unfortunately, are almost always pure guesswork and one person's guess is as good as another.

Any word yet of that thin-branched *Carya alba?*

155

December 10, 1917.

I have been in Florida for a few days looking at *Quercus laurifolia*, etc., and returning here find yours of the 3rd.

I am sorry that we are still short of that Wakefield Hickory which if it is a form of *Carya alba*, is certainly interesting.

Yes, I know H. S. Dawson who is the son of a man who for many years was Superintendent of the Arboretum. There are few people probably in the United States who are less fitted for intelligent planting in Louisiana as he knows nothing of the southern vegetation. Ness I know about, that is if he is the Professor at the University of Texas who has raised a *Quercus virginiana lyrata* hybrid which is identical with our Natchez tree.[15] I am more than ever convinced that *Q. laurifolia* has not been collected yet in Louisiana. It grows in Mississippi City on the Sound and if it was anywhere in Mississippi it would be in the Hammond region which ought to be examined further for it. I will send you one of my Florida specimens in a few days to guide you in any hunt you may undertake.

156

December 24, 1917.

The Lake Charles Oak which we called [*Quercus*] *laurifolia* I take to be *Q. rhombifolia*. There is no fruit. I am placing with *Q. rhombifolia* also Palmer's 8487 from Welsh, your Mandeville specimen 4698, your Pineville specimen 4702, although this last may be a hybrid, your Springfield March 1917 (type), and your 4710, your Slidell 4708 and your Sardis 4706, also 4712. I think we shall have to consider this a species.

I have a leaf specimen of Ness's *lyrata* × *virginiana*, hybrid, and a photograph of the fruit produced by his plant and they seem identical with the Natchez-New Orleans tree. It is a wise parent who knows his own offspring.

Please do not forget that you are going to send me specimens of *Carya pallida* from near Alexandria.

Louisiana *Crataegus*. I have been talking with Harbison about the species of *Crataegus* which he discovered near Opelousas. Cocks's 39 from Natchitoches equals *C. edura* Beadle. We have Beadle's cotype but you and I do not appear to have collected this species near Opelousas.

C. albicera. We have a cotype collected one mile south of Opelousas in fruit. We do not seem to have collected it.

C. coccinea. We have a cotype collected seven miles west of Opelousas. We have n't collected this.

C. tersa is our No. 2 from west of Opelousas. April 4, 1913. Your unnumbered specimens of April 1914 and my specimens in fruit of Nos. 3 and 6 of October 1913 are this species.

Beadle writes, — "I see by my notes that it is *C. albicera* that has

[15] Ness, H. Hybrids of the live oak and overcup oak. Jour. Heredity 9: 263–268. 1918.

pure yellow and edible fruit. Under this species I said in fall of 1901, 'large yellow fruit, just getting ripe, acid, good to eat.' The type tree is in low woods seven miles west of Opelousas. *C. crocinna* [sic] is another yellow one ripening its fruit about a month later than that of *C. albicera*. This grows in the same low woods west of Opelousas. *C. edura* and *C. tersa* have red or ruddy fruit, not edible. These trees grow in upland woods and I think the type trees are within half a mile of Opelousas. I am not positive, however, having no record of the number of the type trees. South and east of Opelousas was a large enclosure used for pasture. In this enclosure is where I first found these species. I went along the Railway in the direction of Lafayette half a mile or less and climbed the wire fence and back in this woodland pasture is where I found the trees. There must be some *C. albicera* in the vicinity of Opelousas for I found yellow fruit under a *C. edura* tree and collected it by mistake, afterwards learning from a boy that he and other boys pelted some girls with yellow haws while they were sitting under that tree eating grapes."

Really a yellow-fruited *Crus-galli* species is rare. I certainly never went to this station south of Opelousas which Harbison talks about and I wonder if you have been there. This might be a good place to visit sometime if you want to get material of these Hawthorns.

With best wishes for the New Year, I am,

157

January 16, 1918.

I have been looking at Oaks lately and think that Palmer's 7448 and 7473 Natchitoches are only a large-leaved form of Q[*uercus*] *nigra*.

Quercus 1002, Sardis, is I think *marilandica* × *velutina*, a common hybrid which is not rare & is widely distributed. I think of calling this *Q. Bushii* as it appears to have been first collected by Bush.

Cocks's 4702, Pineville, April 1917, looks like a hybrid between *rhombifolia* and *velutina*. Did you get it again in the autumn? Fruit and mature leaves should be collected. This seems to be quite a new hybrid and looks interesting.

Cocks's Selma 4704. For a guess this may be a *Catesbaei* and *nigra* cross, and to this cross Trelease has given the name of *Q. Walteriana* ined. I am not entirely satisfied with this guess, but *Catesbaei* is surely one parent.

Have you ever made that trip to the Chandeleur Islands?

I am sorry to see that you are having very cold weather with snow at New Orleans, and I am afraid there has been a good deal of damage done to plants. This has been the worst winter here I can remember so far as cold is concerned but we have n't had yet much snow. I hope you are well.

158

January 16, 1918.

The Oak Ashe has tried to write you about is his *Quercus rubra* var. *leucophylla*. I enclose a copy of his original description from the Bulletin

of the Charleston Museum.[16] This Oak has long troubled Harbison and me, and I am glad that Ashe has made what seems to be a good disposition of it. The only Louisiana specimens I have seen are Palmer's Natchitoches 7443 and Welsh 8486, Cocks's Mandeville 1787, May 1908, as *Q. pagodaefolia*. I collected it at Lake Charles April 13, 1915, and the only Selma specimen I have seen is Harbison's #20 "in woods west of the city, April 1915."

I never told Ashe that it was the largest tree in the swamps in any part of Louisiana for I have seen very little of it in your state. What I did tell him I think was that it was one of the largest trees in the swamps about River Junction, Florida.

The Springfield tree I am describing as *Q. rhombifolia*. I am glad to know that it holds its leaves later than *nigra*.

How about this evergreen *Q. Phellos* you speak of? Isn't there some mistake, and have you not got hold of *laurifolia* which is evergreen and which has leaves a good deal like those of *Phellos?*

159

February 13, 1918.

I shall write you in a day or two at some length about the *Quercus* situation in Louisiana and I am only writing today to call your attention again to your Oak No. 6 from St. Tammany July 1900.

I cannot make anything out of this but *Quercus borealis* and *Q. borealis* is the most northern of the Atlantic Oaks and grows only in very cold regions. If your tree is really this species its presence in Louisiana is beyond my understanding. This is a matter certainly for further investigation and it will be interesting to know if this tree is common.

In my Manual *Quercus Catesbaei* is credited to eastern Louisiana, but there is no specimen from Louisiana in this herbarium. There is no specimen either of *Q. cinerea* from eastern Louisiana where it might be expected. You ought to try and find some sandy region in Louisiana east of the river, for if you can I think you will find growing on it the thick-leaved *Q. virginiana, Q. cinerea* and *Q. Catesbaei.*

We have only one specimen of *Q. marilandica* from Louisiana, Palmer's No. 7517. There is no indication that this tree grows in eastern Louisiana and no specimen collected by you. We have no specimen of *Q. Prinus* (*Michauxii*) from western Louisiana, and no specimen of *Q. rubra* (*falcata*) from eastern Louisiana collected by you. We have no specimen of *Quercus lyrata* from eastern Louisiana and none collected by you or me in Louisiana.

It looks to me as if more attention should be paid to eastern Louisiana for the determination of the distribution of Louisiana trees. There does not seem to be any reason why trees growing at Biloxi and Mississippi City should not cross the Pearl River if there is any sandy soil for them to grow in.

[16] Ashe, W. W. Bull. Charleston Mus. **13**: 25, 26. 1917.

160

February 15, 1918.

I have this morning your letter of the 11th with specimen of *Quercus*. The twigs to which you refer are not in the package and I suppose will arrive later.

I never heard of the man Neal who has been appointed Superintendent of Audubon Park.

Your evergreen Willow Oak from Sardis is, as I suspected, *Q. laurifolia*. This makes a new tree for that apparently inexhaustible region. *Quercus laurifolia* is one of the best street trees in the world for the southern states and there is no better tree for New Orleans. It is worth going to Jacksonville, Florida, to see the Laurel Oaks which have been planted there.

161

February 15, 1918.

I have your note of the 24th and am now ready to report on the Louisiana Oaks.

Quercus rhombifolia I find was used by Riddell for one of his species described in 1853 in the New Orleans Medical Repository, so I have substituted *rhombica* for the new Water Oak.

Post Oaks.

There are two distinct forms of Post Oak, the first with stout tomentose branches and the other with slender glabrous or nearly glabrous branches. To the first group belongs the typical *Quercus stellata* with the upper lobes of the leaves broad and truncate or slightly lobed. To this I refer Palmer's No. 8492, Welsh, and Natchitoches No. 8912. We collected it on March 29th last growing on dry ground near Springfield. Of the form with glabrous branches the most common and widely distributed is the variety *Margaretta* Ashe with usually rounded lobes to the leaves, glabrous above and loose pubescent below, slender reddish branchlets and very close bark. From Louisiana I find only one specimen which seems to belong to this variety, Palmer's No. 9465 from Chestnut, with young leaves only, and a specimen collected by Letterman at Shreveport July 23, 1891. This variety grows at Selma and I am calling the little running Selma Oak *Quercus stellata* var. *Margaretta* f. *stolonifera*.

I propose the name of *Quercus stellata* var. *araniosa* for the Post Oak with scaly bark and loose cobwebby tomentum on the lower surface of the leaves which have both square and rounded lobes. The numbers are Palmer's 8770, Grand Ecore (type), 7518, 8769 and 9446, Grand Ecore; 7978 and 8838, Chopin, and 7361 Natchitoches. I suggest the name *Q. stellata* var. *paludosa* for the Washington trees with scaly bark, making your No. 4734 the type. This variety is distinct in its scaly bark, in the shape of the leaves and in the close tomentum on their lower surface.

I am afraid we must call your Sardis numbers 898, 912 and 940 the Scarlet Oak after all, much as I dislike the idea of a Scarlet Oak growing

so far south. I suggest *Q. coccinea* var. *tuberculata* for it, making No. 898 the extreme form of the type.

On April 4, 1913, we collected in low wet woods west of Opelousas specimens of a large Post Oak with scale bark, hoary-tomentose branchlets and square-lobed leaves covered below with yellowish brown tomentum. You collected probably from the same tree on April 3, 1916 (No. 4022). The mature leaves and fruit of this tree have not been collected. On April 3, 1913, we collected in the same locality what must be another form of Post Oak, also with scale bark, the leaves with square lobes but sparingly pubescent below, and stellate-pubescent, not tomentose, branchlets. You have n't collected autumn specimens from either of these trees, but your Natchitoches specimen, October 1913, a tree with broad lobed leaves, might be the same as the second of these Opelousas Post Oaks, as may be Palmer's Welsh 8491 in low wet woods.

The Post Oaks west of Opelousas should be followed up this year for, with the exception of them and your Pineville hybrid, all the Louisiana Oaks which we have seen are now accounted for. Other hybrids will no doubt be found, and I confidently expect you to send me specimens of *Quercus virginiana geminata* and *Q. laurifolia* as these are common at Mississippi City and should reach the extreme western parishes.

Most of the Louisiana Live Oaks are typical *Quercus virginiana*, but for the little Oak with pale bark and small leaves from the neighborhood of Springfield I am suggesting the name of *Q. virginiana* var. *eximia*. Your 4716 is the type. Other numbers are 4718, 4720, 4722 and 4726.

The Live Oak with strongly reticulately veined leaves revolute on the margins and tomentose below I call *Q. virginiana* var. *geminata*. This has not yet been found in Louisiana but it is so common in southern Mississippi that I am sure you will find it somewhere west of the Pearl River.

Quercus texana Shumardii is my name for the Texas Oak with shallow cups with often much thickened scales. It is Palmer's Natchitoches 7442, 8761, 8762 and 9420; Mooringport 9408; Grand Ecore 7522, 9451; Shreveport 9481; Lake Charles 8522; Lake Charles, collected by us April 12, 1915, a tree one hundred and ten feet high. Cocks, East Opelousas, 4020, Richland County, June 21, 1905.

The variety with deeper cup-shaped or turbinate cups I call *Quercus texana* var. *Schneckii*. This we collected on the West Plantation April 14, 1916, on the Fort Plantation (Nos. 1 & 2), April 13, 1916, on the Dessert Plantation April 14, 1916, near Laurel Hill, March 28, 1910. It is Palmer's 8735, Windsor (very typical), Chopin 8835. It is your Richland No. 1915, September 21, 1910, 8935?; and our Monroe, October 8, 1913.

I have no evidence that the variety *Shumardii* grows in Louisiana east of the river, but it is so common in Mississippi and Alabama I should expect to find it there. The typical *Q. texana* has deeply lobed leaves and small acorns with turbinate cups, and is found only on the limestone hills of central and western Texas.

Quercus nigra var. *tridentifera*. I suggest this as the name for the Water Oak with leaves distinctly three-lobed at the apex. We collected it April

13th near Laurel Hill and this I consider the type. We also collected it at Lorenger March 30, 1917. You collected it in Audubon Park October 1913, and I collected it probably from the same tree in Audubon Park, March 31, 1917. There is a well-marked small tree of this variety in the fence row by road (right hand side) leading from Selma to Sardis.

Quercus rubra var. *leucophylla* Ashe in Bull. Charleston Mus. xiii. 25 (April 1917). To this variety, which has probably been taken. without the fruit having been seen, for *Q. velutina* and sometimes for *Q. pagodaefolia*, I now refer your *Quercus pagodaefolia* (?), Mandeville 1787, May 1908, our Lake Charles, April 13, 1915, Palmer's Welsh 8486, and Natchitoches 7443. This tree needs further investigation for its distribution in Louisiana. The leaves on upper branches are deeply lobed and pale-pubescent on the lower surface, but on lower branches they are less deeply lobed with usually five broad lobes, and are green on the lower surface. Harbison has noticed that the hilum of the seed is pink.

Quercus rubra var. *triloba* Ashe is the name of the Spanish Oak with leaves three-lobed at the apex. There is no specimen of this variety here from Louisiana, but as it grows at Biloxi and near Natchez, I should expect to find it in eastern Louisiana. We have very little *Quercus velutina* from Louisiana, only Palmer's specimens from Shreveport and Natchitoches, your West Feliciana 2600, May 15, 1915, your Richland 1, January 1908, and a specimen collected by Mohr at Shreveport November 1880. None of these will pass for the variety *missouriensis* which should be looked for in western Louisiana as it grows at Fulton, Arkansas. I shall be glad of more *Q. velutina* to show its range in the state.

Quercus Comptonae. I am giving this name to the Natchez Oak which we think is a hybrid between *lyrata* and *virginiana*. This is your tree which is in Audubon Park and in one of the New Orleans streets. Please give me the name of the street where we saw it.

What do you say to calling your Selma 938 and 814 a *cinerea* and *rubra* cross? To this cross Trelease has given the name of *Q. subintegra*. I have placed it in that group.

Quercus 4702. This is probably a *rhombifolia velutina* cross. It is interesting and I should like to see the fruit. This number I hope you will follow up.

Please tell me if this Pineville is across the river from Alexandria. I have tried again to determine Riddell's Oaks in the New Orleans Medical Repository but I can make nothing out of them at all satisfactory. Might not his *rhombifolia* from Alexandria be your 4702?

I don't find Alabama 968, but 938 which is *subintegra* Trelease.

With our present knowledge of Louisiana Oaks it ought to be easy now to find out more about them, and especially about their distribution. I hope you will collect them whenever you have the opportunity. I do not think Richland Parish and the Arkansas border parishes have been sufficiently explored. Can't you manage this? The parishes along the Pearl River also need a careful search. We need specimens of the shrubby

Willow from Louisiana you have spoken to me about. I do not think we have it here.

I shall have another go at the *Tilias* as soon as I have finished *Quercus*.

162

February 18, 1918.

The Japanese *Quercus* which they are planting in New Orleans is *Quercus glauca*,[17] a widely distributed species in Japan, China and the Himalayas. It is a very fine tree, of course, but not as good for New Orleans as *Q. laurifolia* which I wish they would plant there. Do you happen to know where they got *Quercus glauca?* I did not know that it was cultivated in the United States.

I suppose that I told you our *Malus* No. 2 from west of Opelousas was *M.* [unpublished binomial for *M. ioensis* var. *creniserrata*]. I believe now that the Louisiana *Malus* situation has been cleared up.

163

February 21, 1918.

I am glad to see by yours of the 18th that *Quercus marilandica* and *Catesbaei* grow in eastern Louisiana. I should like to have specimens of all the eastern Louisiana Oaks to show their distribution in the state. This is important with the commonest species, for it is impossible to remember the distribution of every tree without reference to the herbarium.

I should think it possible that you could find *Quercus laurifolia* cultivated in New Orleans. If it is there it would be an indication that it was brought from Eastern Louisiana, for I do not think that there are many nursery grown native Oaks planted in the south.

I am proposing to call the Pineville hybrid which looks very distinct to me *Quercus Cocksii* as there does n't seem to be anything better in Louisiana in the way of an Oak for that name. I hope you will get more material.

I hope about the middle of April to get down to North Carolina for a few days, but I am very much afraid I shall not be able to see you in Louisiana this spring; but you will have enough to do without me.

I have been working for two months on *Quercus* and am now going to take up *Carya* and *Tilia* again.

164

March 1, 1918.

Tilia 964 Sardis I suppose is what we have called *T. heterophylla*. 1200 Sardis has all the earmarks of *T. americana*, now to be called *T. glabra*, but I hate to believe that this tree grows in Alabama. Still this is not perhaps as remarkable as it is to find *Q*[*uercus*] *borealis* in Louisiana.

#1202 looks like 1200, except that the axillary tufts are wanting or

[17] This oak, the commonest species in Japan, has evidently been lost in the New Orleans area.

very small. With these I suppose belong Selma 822 equals 784, 6, 960 and several specimens without numbers collected by you in 1914. Also "Tilia americana," Wakefield, West Feliciana, June 1907, and "Tilia americana" near Alexandria, June 1907. These last should be looked up and more should be known about them.

1204 Sardis seems the same as 1202. 962, 970, 782 and 836 Sardis are all incomplete. 962 and 968 Sardis have loose pubescence on the lower surface of the leaves, that is it is easily rubbed off. I do not know what these are. Young leaves and flowers are desirable.

There is still the tree by the Ferry at Lake Charles to complete. It is our #2 and flowers have not been collected unless your specimens from edge of Lake Charles collected May 10, 1911 but not numbered is that species. Some one has written on the label in pencil "referred to 4740" whatever that may mean. The leaves of this specimen have lost the lustrous bluish colors so conspicuous on the March specimens of #2. I judge that this Ferry tree blooms before the other species as the flower-buds on March 23, 1907 were pretty well developed. I think this must be an undescribed species. It is nearest, perhaps, to *T. nuda* but differs in the lustrous lower surface of the leaves and in its early flowers, for *nuda* seems the last of the Louisiana species to bloom. We badly need flowers and fruit of this tree. There are other #2's about Lake Charles but I do not remember exactly where they are situated. I hope you can manage these this year.

I do not know as it is any use sending Ashe any specimens of unpublished trees. He does n't really want them, that is he does not maintain a herbarium, and it is just as well for him and others to wait until these questions are definitely settled and the descriptions printed.

I hope you will let me hear that you can manage this Lake Charles business.

165

March 4, 1918.

Since writing you about *Tilias* a day or two ago I notice that in your letter of October 20th you say you were sending the Lake Charles Linden from the edge of the lake by the ferry. I do not find this specimen unless it is the one in flower collected several years ago which I mentioned in my letter to you. It is astonishing how much trouble this tree gives us. Please let me know about the specimen mentioned in the letter of October 20th.

166

March 5, 1918.

I enclose leaves of a *Bumelia* collected by Palmer at Beaumont, Texas, which agree with the type of Small's *B. lucida*.

You remember *Bumelia lucida* was credited to Louisiana by Small but I believe you have n't found it there. As it grows at Beaumont [Texas] I should suppose the place to look for it would be in the Lake Charles region.

167

March 13, 1918.

I have your letter of March 9th. It is hard for me to believe that your mounted specimen "Lake Charles, edge of the lake, May 10, 1911" is the Ferry tree. Notice that the leaves on the mounted specimen are decidedly pale on the lower surface compared with your Lake Charles March 26, 1911, which is green and lustrous below. This is our old No. 2 and I think is still undescribed. The mounted specimen looks to me like a [*Tilia*] *nuda*. We collected #2 March 26, 1911, April 12 and 13, 1915, and March 23, 1917. This tree has much larger leaves than those on your mounted specimen, slightly pubescent when they first appear especially on the midribs and veins, but soon become glabrous and are more lustrous on the lower surface than those of any species I know.

I think many of our No. 2's were collected down in that wood on the Lake Charles side of the river where we found so many big trees. If I am right in thinking your mounted specimen is a *nuda*, then we have no flowers whatever of No. 2 and no fruit of it at all. Evidently we have n't got to the bottom of this business by any means. Is best you take this up.

Since I wrote you about Oaks I have again reviewed the *Quercus texana* business and have reached the conclusion that it is perhaps best to separate *Shumardii* from *texana*. Geographically the species are different and there seems to be pretty constant characters in the winter-buds and color of the branchlets by which they can be separated. Under this new plan the Louisiana trees are *Q. Shumardii* with shallow cup and *Q. Shumardii* var. *Schneckii* for the tree with deeper cups.

What appears to be *Celtis georgiana*, which I think is nothing but *Celtis pumila*, has been discovered by Palmer in Texas, and as it is a common tree in the southeastern states I should expect it might turn up in Louisiana; at any rate it would be well to make a special attempt to collect *Celtis* in Louisiana. We have no *Celtis* material other than that collected by Palmer in the western part of the state. There is no *Celtis* here from eastern Louisiana collected by either you or by you and me together.

What are you doing about *Quercus myrtifolia?* I hope you are not going to have a spring frost to destroy the growth of the early spring.

168

March 18, 1918.

I can help you very little with your Louisiana *Crataegus*. The species from Holtonville, 2496, is *C. silvicola* Ashe. I do not know why I have never thought of this before. Perhaps the fact that this species has been found at Jackson, Mississippi, attracted my attention to it. As you know, the flowers of this have not been collected.

Crataegus opaca Hooker. I am not sure that I have told you that this is the name for the Louisiana tree which has been called *C. aestivalis*. We ought to have specimens from western Louisiana.

The Lake Charles *Crus-galli* species in yard on road to the river from the town is *C. Bushii* Sargent.

C. edita Sargent, Natchitoches, Bush #4, April 1, 1909, Cocks xvii. April 24, 1912.

Crus-galli species, stamens 20; anthers white; "high ground." Lake Charles, C. S. Sargent, April 10, 1915, is *C. uniqua* Sargent in Trees and Shrubs, ii. 237. This is a rare species originally from Marshall, Texas, and a good Louisiana find.

Palmer, Natchitoches No. 10 (7291 and 8721) is *C. fera* of Beadle.

I want to call your attention to the following:

Cocks, Pineville, *Crus-galli* species just out of flower April 5, 1912. Flowers, color of the anthers and fruit needed.

Crus-galli species, flowers April 24, no year, fruit not dated. Color of anthers needed. These two Pineville species look distinct.

Cocks, *Crus-galli* species, Natchitoches xii., xiii. and xvi., April 24 and 25, 1912, equals Palmer 7290, 8722, 9440. These all seem the same and a new species with twenty stamens and yellow anthers, a rare combination.

A *Crus-galli* species collected by us in low woods, West Lake Charles, March 23, year not on the label, 1917? This has ten to twelve stamens and pale rose anthers. I do not find any other Louisiana specimen like this. Do you remember the tree? Fruit is needed.

In August 1901 Bush collected at Minden a sterile branch of a distinct looking *Crus-galli* species "on right side of road to prairie west of town, in woods close to road, about three and a half miles from town and beyond spring." He collected another *Crus-galli* near Minden at the same time of which he says, — "Common in woods." I collected at Minden on April 15, 1901, a *Crus-galli* species in flower but made no notes on the color of the anthers. Is not Minden a place to explore?

Westfield *Crataegus*. #1, stamens twenty, anthers rose. This is the tree with very narrow leaves near the quarry and a new species. #2, stamens twenty, color of the anthers not noted. Is this the *Crus-galli* species we studied on the right-hand side of the road not very far from town on the way to the quarry? Have you the color of the anthers? My label "near quarry" on this number, but if it did grow by the quarry I do not seem to have a specimen of the roadside tree.

The *Flavae* species from roadside, West Feliciana. We have fruit collected by Mrs. Butler but no flowers and the color of the anthers should be known. It seems nearest to *C. abbita* Beadle but the pedicels and calyx-tube are more densely pubescent and the leaves of *C. abbita* do not have the very conspicuous clusters of white hairs in the axils of the leaves found in the Feliciana plant. I presume that all the plants of this group which we saw in West Feliciana are of the same species. This plant is especially interesting as the only *Flava*[*e*] species which we have found in Louisiana, and as the species of this group which grows further west. I hope you can get the flowers. Could n't Mrs. Butler collect and press them for you? This plant blooms very early.

Viridis species. You can add *C. velutina* Sargent (Trees and Shrubs,

ii. 238) to the Louisiana species as I find a specimen of it which I collected at Shreveport April 20, 1901. This is not surprising for it is common at Fulton, Arkansas.

Viridis species. A tree with dark rough bark in yard of house by road below Lake Charles. The stamens and anthers agree with those of *C. enucleata* Sargent, but the leaves have n't the very conspicuous axillary tufts of that species. The flowers are larger. This seems an undescribed species. Fruit is needed. You remember what a very handsome plant this was.

On October 8, 1913, we collected a *Viridis* species in low woods near Monroe. This was a large tree and had dark scaly bark, and was growing with *C. opaca*. Bush collected what I take to be the same thing August 10, 1900, near Minden "on right side of road to prairie west of town, just before getting to spring. Bark of trunk rough, dark, scaly and flaky, exactly as in *C. aestivalis* which is beside it." This seems to me an undescribed species and we ought to have flowers, color of the anthers, etc.

There are a number of interesting *Crus-galli* and *Viridis* species collected by Palmer in western Louisiana of which I have n't yet the color of the anthers. With that information I shall probably be able to refer some of these to described species.

I have a number of fragmentary *Viridis* specimens, including your # X. from Natchitoches April 5, 1912. The most interesting of these fragments are some sterile branches of a shrub two to three feet high with three-lobed leaves at the ends of the branches which I collected at Monroe April 13, 1901. Did you ever see such a thing?

I have discarded as hopeless the *Viridis* species on the roadside east of Opelousas as this tree has been cut down, and Richland specimens of *Viridis* species 16 and 23 of 1908 collected by you.

It is surprising that there are no *Mollis* species in western Louisiana for they are very common in Fulton, Arkansas, and eastern Texas; and I do not remember any species from eastern Louisiana but *silvicola* and *brachycantha*, and the *Flava* species. There must be others there.

Don't you think it would be a good idea to make a serious *Crataegus* drive this year and see if we cannot get this business closed up? So far as trees and shrubs are concerned there is n't anything else very important to do in Louisiana with the exception of a more thorough exploration of the eastern part of the state where I feel sure you will find species not now recognized as belonging to the state.

169

March 28, 1918.

I have yours of the 25th. When we collected the *Flavae* species in West Feliciana, the plants were out of bloom and we did not get the color of the anthers. It is possible but hardly probable that there are two *Flavae* in West Feliciana.

Crataegus opaca of Hooker is the only May Haw of Louisiana and

Texas and was first collected by Drummond. It is quite a different plant from the Carolina species of that name.

I hope you will be able to finish up *Crataegus* this year, and there is still that *Carya alba* with slender branches to dispose of.

You will, I am sure, be sorry to hear that my son who was so often my companion in Louisiana died in his sleep last week of what was probably some heart trouble. He was perfectly well and in the best of spirits when he went to bed in the evening. This occurred at French Lick, Indiana. We have been so often together in different and often remote parts of the world that the bond between us was a very close one.

170

April 5, 1918.

You collected an interesting *Crus-galli Crataegus* species at Sardis with villose corymbs, yellow anthers and ten stamens, your No. 1008. There is no fruiting specimen and only a couple of half-grown loose fruits. Perhaps you will be able to get fruiting specimens if you are in Alabama this summer. So far as I can see this is undescribed. Harbison does n't seem to have collected it, but he collected a *Crus-galli* species in your region with ten stamens and rose-colored anthers. Of this there is no fruit either.

There appear to be a lot of *Flavae* in that region, but, as I have already written to Harbison, there is n't a single fruiting specimen to go with either yours or his flowering specimens. I have asked him to look out for this and perhaps you will do the same.

171

April 9, 1918.

Thanks for your last letters. I am sorry to hear that Crataegus is beginning to misbehave itself this spring. The *Crus-galli* I should think would still be in flower for it is generally very late.

Is it not No. 1 with the broader leaves which is the tree by the roadside at Winnfield and No. 2 the tree of the quarry with a tall very slender stem and a small head of small branches? This is the way I have them numbered, but apparently you consider No. 2 the roadside tree.

172

May 10, 1918.

How are you getting on and have you found any new Louisiana trees? And are you doing anything about that wretched Ferry Linden at West Lake Charles?

I have a note that *Carya cordiformis* grows near the coast in western Louisiana. This I suppose would mean Lake Charles, but I can find no specimen here from western Louisiana except from Natchitoches and near Opelousas. Did you ever see it about Lake Charles or anywhere near the coast?

How about the specimen of *Carya pallida* from near Alexandria?

ARNOLD ARBORETUM, HARVARD UNIVERSITY,
JAMAICA PLAIN,
MASS.

May 10, 1918.

Dear Professor Cocks:

How are you getting on and have you found any Louisiana trees? And are you doing anything about that wretched Ferry Linden at West Lake Charles?

I have a note that Carya cordiformis grows near the coast in western Louisiana. This I suppose would mean Lake Charles, but I can find no specimen here from western Louisiana except from Natchitoches and near Opelousas. Did you ever see it about Lake Charles or anywhere near the coast?

Faithfully yours,

C. S. Sargent

Professor R. S. Cocks,
New Orleans, La.

FIG. 1. Letter from SARGENT to COCKS (no. 172 of this series) with postscript in Sargent's difficult hand.

173

May 22, 1918.

I am finishing up my long delayed *Carya* paper and am going over the *leiodermis-callicoma* group.

No. 5 from east of Opelousas is the type of *C. leiodermis* and I don't know how to distinguish *C. callicoma* from it except by the smaller fruit and a thin husk and the bright red color of the young leaves, and I am not sure that the young leaves of *C. leiodermis* are not sometimes red. Do you know? Both forms seem to grow east of Opelousas and at Lake Charles where the red leaf is the most common. *C. leiodermis* was collected at Hammond, on the road from Springfield to Pontchatoula, May 29, 1917, and near Loranger March 30, 1917. This I think is the same. It is the tree I thought might be an *alba* with thin branchlets.

I think now our Winnfield tree near the quarry which has bothered us for so many years is also *C. leiodermis*. We got it west of Opelousas March 26, 1917, and it is I think your Natchitoches No. 2, October 1913, and No. 17, September 1914. It grows, too, at Natchez. If you know any character by which *callicoma* can be kept as a species please tell me, otherwise I shall call it *leiodermis* var. *callicoma*.

Your No. 5, Natchitoches October 1913, seems to be an *arkansana* which I shall call *C. Buckleyi* var. *arkansana*.

This seems to finish up all the unplaced *Carya* material from Louisiana. Now it is up to you to find something new.

174

May 25, 1918.

Palmer's Lake Charles No. 7682, Natchitoches 7411 and 7394, Grand Ecore 7524 and Chopin 7412 seem to be *Carya leiodermis*. They may belong to the variety but these specimens are without fruit and it is impossible to say whether they belong to the species or variety. It seems safer to put them under the species.

175

May 27, 1918.

Britton in his tree book says that the Nutmeg Hickory is called Bitter Walnut in Louisiana. This must be a fake story for in the first place the kernel is not bitter, and secondly is so rare in Louisiana that it cannot have secured a popular name. Moreover, it was not known to grow in Louisiana until after Britton's book was published, and he does not include that state in its range. I do not suppose that you have ever heard it called anything but Nutmeg Hickory.

176

May 29, 1918.

I am very glad to get the package of plants. The Ferry *Tilia* specimens are fine. I felt sure that if you stuck to the job long enough you would find

Quercus laurifolia in Louisiana and now you have done it. The little White Oak is a dwarf form of *Quercus stellata Margaretta*, and if it spreads by underground stems I do not see why it is not the variety *stolonifera* which grows at Selma.

We cannot see here anything in your *Leucothoë* but *axillaris* which varies greatly in the width of the leaves. I do not think there is anything in Small's species especially as broad and narrow leaves appear to occur and sometimes on the same plant. I hope you will find more things in eastern Louisiana.

177

June 4, 1918.

I send you a copy of my *Quercus* paper. Your Live Oak should be, of course, *Quercus eximia* and not *Q. eximea*.

178

June 11, 1918.

We have nuts but no leaf specimen of your *Carya laciniosa* from Berlin [Alabama]. Can't you dry one for us if the tree is still alive?

179

June 19, 1918.

Your *Carya* 4030 near Kentwood, Tangipahoa, is probably a *leiodermis*, but 4028 is *C. pallida* and the only intimation we have here that it is a Louisiana tree. I wish I could see your specimens from Alexandria.

I believe that you will find both *Carya Pecan* and *C. texana* in West Feliciana as these two trees occur at Natchez. They are certainly worth looking for.

We have no specimen of *C. ovata* from eastern Louisiana where no doubt it occurs. It is rather curious that we have no Alabama specimen of *C. ovata* except from the Selma region. I wonder if, like *C. laciniosa*, it only grows there in the state.

I have about finished up what I can do with *Carya*, not a very satisfactory piece of work.

180

July 12, 1918.

Your No. 1761, Richlands P[arish], May 1909, called *C[arya] ovata*, must be a *leiodermis*; certainly it is not *C. ovata*. The specimen consists only of a sterile branch. There is no other thin-branched Hickory in Louisiana but *leiodermis* to which it can be referred. I have finished my *Carya* paper and sent it to the printer, and now I must make my annual onslaught on *Tilia* which is by far the most difficult of all the groups.

I believe you haven't collected in Louisiana any *Azalea* but *A. nudiflora*. There is an *Azalea* in the swamps at Biloxi which seems to be a new

species, and *Azaleas* other than *nudiflora* are common in southern Arkansas and eastern Texas. Isn't this the genus that needs your attention?

I hope your crops are prospering.

181

July 16, 1918.

If everything, as you claim, grows in Selma and its neighborhood how does it happen that you have not found there a *Philadelphus?* Two species are credited to the state, although there is nothing in this herbarium to show that they really grow in Alabama. It might be worth while to look about for one of these plants in your region.

182

July 22, 1918.

The package of specimens has arrived. If you say that these *Tilia* specimens came from our tree by [the] ferry I suppose I shall have to believe you, but I have never seen *Tilia* behave in such a disgusting way before. I do not know what to think of it.

I am glad you sent the Hickory specimen for it is not *Carya laciniosa* at all but *C. tomentosa* variety *subcoriacea*. It is surprising that it should grow, however, in low ground. What sort of bark have these trees got? Please let me know about this as my paper on *Carya* is already in the hands of the printer. Your *laciniosa* from West Feliciana Parish seems to be all right.

183

July 29, 1918.

I have your note about *Philadelphus* and *Azalea*. I find your specimen of *Philadelphus* which has been placed under *P. inodorus*. This species and *grandiflorus* are very closely related.

The *Azalea* which you say you sent from Pearl River eight years ago we are unable to find. I should like another specimen sometime if you have one to spare. I suspect that it may be the new species from Biloxi. Is there no summer-flowering *Azalea* about Selma, or any *Azalea* except *nudiflora?* Harbison is finding several new species and I should not be surprised to find that some of them are in your neighborhood.

184

August 12, 1918.

I am much obliged for the Alabama specimen of *Carya laciniosa*. Judging by the color of the branchlets and the fruit there can be no doubt about the correctness of the determination, but the leaves are remarkably glabrous on the lower surface for this species.

I have at last finished my paper on *Tilia*, so please do not find any more new species about Selma. I think Louisiana, at least, is exhausted.

185

August 17, 1918.

Will not this autumn be a good time to collect *Crataegus* for the fruit in the hope of completing the specimens next spring with the flowers? Do not forget that *Quercus Cocksii* needs a good deal more investigation.

The *Azalea* in swamps at Biloxi is certainly a new species which grows also in the central peninsula of Florida and in southern Georgia where it is sometimes twenty feet high. It blooms apparently sometimes as late as August 1st. Why should not this be found in some of the swamps near Selma? I should guess that it was the *Azalea* you found once near Pearl River in Louisiana, although I do not think that *Azalea viscosa* gets into the south at all. It would be interesting to find this *Azalea* in both Alabama and Louisiana. I am sure, too, there are other undiscovered plants in eastern Louisiana.

I do not believe it has been as hot in Alabama as it has been here during the past week.

186

November 6, 1918.

I have yours of November 1st. I am very sorry to hear about your accident. That is a bad road between Opelousas and the western woods at the best and I fancy that mules are the safest method of transport over it. I am not surprised that you are knocked out.

I am glad to hear that *Carya cordiformis* grows near Selma but how was I expected to know if you did not send me a specimen? Isn't [what you have labeled] *C. megacarpa stelipila* [in reality *C.*] *leiodermis*? I hardly believe that *Gordonia* reaches Louisiana. Mohr found it at only one station in Alabama. Gray apparently guessed that it grew in Mississippi, at least there is no specimen in his herbarium to show that it grew there, and Robinson lays the blame to Gray. As for Small's statement that it grows in Louisiana, you know how much that is worth.

My *Tilia* paper is so long that it will be published in two parts in the November and December issues of The Botanical Gazette. Do not be discouraged about *Crataegus*. We shall certainly be able to get material we want next year.

187

November 27, 1918.

I am glad to get your letter of November 18th and the package of plants.

"Azalea viscosa" is certainly the same as the species at Biloxi, Mississippi, which is common in southern Georgia and in the central Florida peninsula. This is evidently a new species which seems to bloom at midsummer in Georgia and Florida and sometimes gets to be twenty feet high. We are slowly getting together here material for a paper on American *Azaleas*.[18]

[18] WILSON, E. H. & A. REHDER, A monograph of azaleas. Publ. Arnold Arb. 9. 1921.

Your *Vaccinium* seems to be *tenellum*, but Palmer's *tenellum*, Morningport 9811 and Natchitoches 9429, called by him *tenellum*, are probably *V. Elliottii* which you seem to have collected at various places in Louisiana.

I hope you are getting ready for a successful *Crataegus* campaign in 1919.

188

December 6, 1918.

The tree which we used to think might be *Tilia glabra* in Louisiana and Alabama I have referred to *T. nuda* in spite of the tufts of hairs in the axils of the veins (see page 427 of my paper). This may not be a proper solution of the difficulty but I do not know how to make it otherwise.

I hope you may be able to distinguish the different species of *Tilia* when you see them in the woods. I certainly never expect to be able to do it. I am not very well satisfied with the outcome of this investigation, but the species show no really good botanical characters.

I have placed your *Quercus* 938 of Alabama with Trelease's *subintegra*. I said nothing about it in my paper for I made no mention of hybrids made by Trelease. His paper contains names only without descriptions or any references to his types.

I do not see much prospect of the appearance of the new edition of the Manual at present. It has taken the best part of the year to prepare the Oak, Hickory and Linden papers, and there are several other genera to work over. Now I am working on *Celtis* which is difficult, but fortunately there are not many species. It will take a year, I suppose, to print the book when it is ready.

Wodehouse it shall be. If a fellow insists on having such a lot of names I do not see how he could expect to get them all spelled correctly. I suspect the neighborhood of Opelousas is still the best part of the state for *Crataegus*. As you know, we never did anything in that region east of the railroad and south of the town that Harbison talks about. As far as I have seen there does not seem to be many species east of the river.

189

December 14, 1918.

In the Kew Herbarium there is a specimen collected by Drummond at New Orleans which proves to be *Salix longipes* variety *venulosa*. We can find no other indication, however, that this species grows in the state. Judging by Drummond's blue-fruited *Crataegus*, he labeled plants "New Orleans" which he collected across the lake. I enclose a few leaves and a flower-spike from a Texas specimen to show you what sort of a looking thing *Salix longipes* is. The species is common in Florida and in western Texas but we have no specimens from eastern Texas or Alabama. The Louisiana station for it seems worth looking up.

You will have to change the name of *Celtis mississippiensis* Bosc to *C. laevigata* Willdenow for it seems that Bosc never gave the *Celtis* which

he said came from the mouth of the Mississippi River a name and Willdenow's name is much earlier than the first published *C. mississippiensis*. It is astonishing how mistakes in botany are perpetuated from one generation to another.

190

December 16, 1918.

There is no *Celtis* in the herbarium from eastern Louisiana where I suppose it is common, and from western Louisiana only specimens collected by Palmer and one by Mohr near Alexandria. Apparently we have never paid any attention to *Celtis* and we ought to have more material here. *Celtis laevigata* must be common in Eastern Louisiana, and possibly *georgiana* which apparently grows in the Selma region.

191

December 18, 1918.

You appear to have got a new Alabama tree in *Celtis occidentalis* var. *crassifolia*, Sardis, 1913, no number. This is a tree with leaves very rough above and pilose below on the midribs and veins, and with pubescent petioles and peduncles. The leaves of your specimen are exceptionally entire for this variety but I do not think it can be anything else. Do you know anything about this tree and is it abundant?

192

December 30, 1918.

I found the other day in the Gray Herbarium a specimen of *Celtis laevigata* (*mississippiensis*) collected by Hale in Louisiana without date or locality, also a specimen of the same tree collected by Carleton R. Ball in the vicinity of Alexandria May 25, 1899 (No. 453).

Now it seems there are no Louisiana specimens of *Platanus* in the herbarium. Have you ever paid any attention to this tree? There is quite an interesting form which grows in Texas and also near Selma where it was collected by Harbison with leaves distinctly cuneate at the base. This form is without a name. I should think it must occur in Louisiana. I wish you would look at your specimens and see if the leaves of any of them are cuneate at the base. This is a genus of which I hope you will collect specimens for the Arboretum next year.

With all good wishes for the New Year, I am,

193

January 6, 1919.

A new tree for Louisiana is *Acer Negundo* var. *texanum* Pax. This is Palmer's No. 7546 from Chopin and No. 7597 from Alexandria. Your specimen collected in April 1901 in swamps at New Orleans, no number, is also var. *texanum*. This is the only specimen we have here from eastern Louisiana where I suppose it must be a common tree. It would be well

to collect it there. We have no specimen of *Negundo* of any sort from the Selma region, or indeed from any part of Alabama. If everything else grows at Selma I suppose the *Negundo* must be there.

194

January 14, 1919.

I am sorry to hear of your continuous hard luck as a planter and I shall be very sorry if you have to abandon your Berlin plantation for the neighborhood of Sardis is one of the best places in the United States for trees and I do not believe that field is exhausted yet.

We have here no specimen of typical *Celtis occidentalis* from Louisiana or Alabama, no *crassifolia* from Louisiana, and only the abnormal one with nearly entire leaves from Sardis about which I wrote you before. If *crassifolia* grows in Louisiana I should know about it at once. *Celtis georgiana*, which is common in the Selma region, I think will be found in eastern Louisiana.

Sugar Maple. The southern form of *Acer saccharum* differs from the common northern form in the glaucous (not green) lower surface of the leaves which are usually slightly pubescent along the under side of the midribs and veins. This is var. *glaucum* (Pax) Sargent. Your No. 2520 from Saint Francisville, May 15, 1915, I feel satisfied is this tree which we collected also with young leaves at Woodville, Mississippi. The Saint Francisville specimen is the only one I have seen in Louisiana. It seems more common in the Selma region where Harbison collected it several times. Your Sardis 825, July 2, 1915, is this tree. It is common in southern Arkansas but no one seems to have found it in western Louisiana where *A. floridanum* is common. The last can be distinguished by the pubescence which covers the whole lower surface of the leaves and by the much smaller fruit. I commend *Acer saccharum* to your prayerful consideration. If you can understand American Lindens I congratulate you for I certainly cannot.

195

January 16, 1919.

I have been studying the Red Maple and am not able to separate the variety *Drummondii* as a species for I find specimens with trilobed leaves rounded at the base which appear to connect it with *A. rubrum* var. *tridens*. For this form I am going to propose the name of *Acer rubrum* var. *Drummondii* f. *rotundata*, making the type Palmer's No. 7553 from Chopin. You got nearly the same form at Glen Gordon, Covington, May 28, 1911. It grows also at Poplar Bluff, Missouri. Unfortunately I have not seen the fruit of this form. Would it be possible to get it from the Covington tree this spring? This is the only *Drummondii* specimen we have from eastern Louisiana. We collected it on our trip to Natchez, near Woodville, Mississippi, so I suppose it grows in West Feliciana. Have you collected it there? This is a Louisiana tree which needs further study, especially in the autumn. Autumn specimens are needed to show the amount

and character of the tomentum on the leaves, petioles and branchlets at that season. Won't you look out for it then and try to establish its range in eastern Louisiana? How large does the Drummond Maple grow in Louisiana? The trees which grow in Alabama and Georgia and which have been sometimes referred to *Drummondii* I want to call var. *tomentosum* Pax. This variety differs from *Drummondii* in the much smaller fruit, glabrous branchlets, glabrous petioles and less tomentose leaves. Moore got this at Mt. Vernon but I do not find it among the Selma-Sardis specimens, or indeed a specimen of any sort of a Red Maple from there — why?

Of what may be considered the typical Red Maple from Louisiana we have Palmer's Natchitoches No. 7571 and perhaps No. 7041, with fruit only. Low woods, Winnfield, Cocks and Sargent, April 6, 1913, and nothing from East Louisiana where it should be looked for. Of the variety *tridens* one Louisiana specimen from West Lake Charles, Cocks and Sargent, April 13, 1915; Fairfax Road, Shreveport, Cocks, April 1, 1910; Butler Plantation, Cocks and Sargent, April 14, 1916; near Hammond, Cocks and Sargent, March 30, 1917; Lucknow, Richland Parish, Cocks and Sargent, March 1910; Winnfield, Cocks and Sargent, October 9, 1913.

The important trees to collect from are the common widely distributed species which show the greatest tendency to variation. These varieties are interesting and have been too much neglected. You are better placed for studying *Acer Drummondii* than any one and I venture to hope that you will pay attention to it and to other forms of the Red Maple.

196

January 20, 1919.

Magnolia glauca will have to be called *M. virginiana* I am sorry to say, and I am distinguishing the southern form with pedicels and branchlets thickly covered with silky white pubescence as variety *australis*. This is usually a large tree and is the only form in Alabama, Mississippi, Louisiana and Texas. I judge by the material here that this is a comparatively rare tree in Louisiana, for in this herbarium there are only the specimens we collected at Winnfield October 9, 1913, and Palmer's Natchitoches specimens numbered 7573 and 7931. These two specimens are remarkable in their broad oval leaves. Unfortunately there are no flowers. I should have supposed that Lake Charles would have been just the place for this tree.

Please notice that we have no specimens from eastern Louisiana and please tell what you know of the distribution of this *Magnolia* in Louisiana. More Louisiana material would be acceptable.

The flowers of our West Feliciana *Magnolia acuminata* are so large that I want to distinguish it as variety *ludoviciana*. I call the type the tree on the Dessert Plantation.[19] Is this name right and is this Plantation in Laurel Hill, and, if not, where is it? We got it also at the West Plantation.

[19] Near Bayou Sara, West Feliciana Parish.

Is this also in Laurel Hill? I suppose your Catalpa and St. Francisville specimens are the same but there are no flowers and the leaves are more typical of the species.

You ought if possible to make a thorough exploration of Louisiana and gather specimens of every tree, even the most common, for it is impossible to tell what may turn up. Can't you manage this?

197

January 27, 1919.

I have yours of January 19th. In regard to *Acer floridanum* we have your two Natchitoches specimens collected in 1902 and 1905, and Palmer's Natchitoches No. 7400; also *A. floridanum* collected by us at the Dessert Plantation April 12, 1916.

I am sure Elwes will enjoy the Louisiana trees. I think, however, that he will fully occupy your time while he is there and that you will have all you can do and listen to without being bothered with me at the same time. If I ever get to Louisiana again I shall hardly select Elwes for a companion. I hope you are going to be able to get all over the state this year and finish up the trees and shrubs.

198

January 28, 1919.

I am glad to hear from yours of the 24th that *Magnolia glauca* is so common in Louisiana. The fact that we did not know this here only shows how poor this herbarium still is in Louisiana specimens. Does it ever grow in Louisiana as a shrub? Please notice if the petiole of the flower is ever glabrous as in the northern form of this tree. On specimens from west of Florida which I have seen all the pedicels are covered with white silky hairs.

199

January 31, 1919.

I am much obliged for the package of specimens which arrived this morning. The two *Magnolia glauca* specimens have the silky pubescent pedicels and are my *M. virginiana* var. *australis*. I fancy that every Louisiana specimen will be of this variety.

No. 658, *Celtis occidentalis* from Sardis is *C. laevigata* (*mississippiensis*).

No. 748, *Acer Drummondii* = *Acer rubrum* var. *Drummondii* forma *rotundata* Sarg., showing a connection of *Acer Drummondii* with *Acer tridens*.

No. 2818, *Acer Drummondii*, is intermediate between *A. rubrum* var. *Drummondii* and the forma *rotundata*.

I am getting a good deal interested in *Acer Drummondii* and wish I knew more of its distribution. I now believe that it does not get east of Mississippi and that all the forms from Alabama, Florida, Georgia, etc.,

which have been referred to it are *Acer rubrum tomentosum*. There is a lot of talk about this in my next Botanical Gazette paper which is booked for the March number.

200

February 4, 1919.

Palmer's *Celtis* from Cameron Parish is No. 3533, not No. 8534 as you say. I do not think it can be anything but a rather small-leaved form of *Celtis mississippiensis* which varies greatly in the size of the leaves and in their broader but narrower bases. We have n't in this herbarium a single *Celtis* specimen collected by you or by you and I. Louisiana certainly ought to be better represented here.

Elwes is all right. He is a gentleman and has already been pretty much all over the world. The only trouble is that he talks too much and too loudly and positively, and so much that he has gone around the world without really seeing anything. It is perfectly all right to take him to Butler's or anywhere else. My only idea was that if I wanted to have a quiet and restful time in Louisiana I should not select him for a member of the party.

201

February 6, 1919.

Your *Acer rubrum* No. 869, New Orleans, is a puzzle. It is not *rubrum* and looks more like *nigrum* than anything else. If it is *nigrum* and not a cultivated tree it is a very long way from where it belongs. Do you remember this tree and is it still in existence? This seems to me a matter worth investigating. As the label says New Orleans I think it may have been planted there.

202

March 1, 1919.

It is some time since I heard from you. Was that *Acer nigrum* from Louisiana too much for you? Small, I see, credits *Castanea nana* to Louisiana. We certainly have no evidence that it grows in the state and there are no specimens here from Mississippi or Alabama. I am getting interested in this plant for Harbison has found a Chinquapin on St. Andrew's Bay in western Florida forty feet high which, although I have not seen the fruit, I take to be a glabrous form of *C. nana* for which, by the way, *C. alnifolia* Nuttall is the correct name. It would be well therefore, if you see any strange looking Chinquapins in your travels, to make specimens. All the forms of *alnifolia* are easily distinguished by the glabrous or nearly glabrous branchlets and much narrower leaves; and by the prickles on the fruit being in distinctly separated clusters.

Elwes seems to be weakening on his trip to America this spring as he has difficulty in getting transportation. He was not, however, quite decided when he wrote last.

What is the *Crataegus* situation?

203

March 10, 1919.

I have this morning your letter of March 6th. I had no idea Ames was in New Orleans. A letter addressed to him at the Ames Building, Boston, will reach him.

I am glad to hear it is a late season with you for this means that there will be a better chance for *Crataegus*.

As I wrote you, the last time I heard from Elwes he was thinking of giving up his trip.

I am planning to impose on your good nature by giving a letter of introduction to you to Professor Blareningham of the Pasteur Institute and the University of Paris. He is here this winter as an exchange Professor at Harvard and is planning a journey south and west which will take him to New Orleans for a day or two sometime before the end of this month. If you could arrange for him to make a trip across Lake Pontchartrain, perhaps that would be the best thing he could do in the short time he will have in New Orleans. He is particularly interested in trees for he has been put in charge of the Arboretum at Angiers which has lately come into the control of the Pasteur Institute. His wife speaks English quite well.

204

March 18, 1919.

Have you ever looked for *Myrica inodora* on the Louisiana side of Pearl River? It grows at Poplarville, Mississippi, and might get further west. Pearl River swamps in Washington Parish would be the place to look for it.

How does it happen that there is no *Myrica* about Selma as we have no specimen from there?

I had another letter from Elwes telling me that with his nephew, a naval officer, he is sailing on the 25th of March for New York. He proposes to go south before coming here. Whatever equipment you may need for your journey with him you certainly will not require an ear trumpet.

205

March 20, 1919.

When you go to West Feliciana with Elwes please pay attention to that species of the *Flavae* Group of *Crataegus* about which we do not yet know enough. You remember, of course, that station of Harbison's just off the railroad below Opelousas which we have never visited.

206

March 22, 1919.

I have yours of March 20th about a Garden Society and I will see if

I cannot find some material in our nursery to send you the first of the week.

They call *Crataegus* beastly, but there is really a lot of fun in them?

207

March 26, 1919.

All the plants which I can find in our nursery at all suitable for Louisiana are mentioned on the enclosed, and go by parcel post. It is a very poor and unsatisfactory list but by another year or two the seedlings of the Formosa trees, all of which I hope will do well in Louisiana, ought to be big enough to send you.

208

April 5, 1919.

We have no specimen of *Chrysobalanus oblongifolius* from Louisiana and I shall be very glad of your specimen from Bogalusa.

I had a letter from Blareningham written in New Orleans. Instead of staying one day in Miami, Florida, as he intended, he staid three. This cut down his Louisiana visit and apparently he only staid a few hours in New Orleans. He said he did not have time to look you up but would write to you explaining why he had not called. This I suppose he will do in time.

I have n't heard yet that Elwes has arrived but I suppose he may get in now any day. I have advised him to go to New Orleans via Jacksonville, Florida, and to stop off at River Junction, Florida. If he does this it may take him some days to recuperate.

I hope you have had a successful time with *Crataegus*, and I regret extremely that I was not with you. I am really pining for another visit to that hotel in Opelousas.

209

May 29, 1919.

Many thanks for the package of *Crataegus* which I have looked over.

No. 3133, *C. viridis* or very near it.

No. 3135, 3136, *C. viridis* or close to it.

Nos. 3137, 3138, 3140, 3146, *C. viridis*.

No. 3144, one of the *Viridis* Group but it looks distinct. Fruit should be collected.

Nos. 3144 [sic], 3148, *Acer rubrum tomentosum*.

No. 3147, *Crataegus* of the *Viridis* Group but it looks distinct. Fruit should be collected.

No. 3149, another distinct looking species of the *Viridis* Group. Fruit should be collected.

No. 3151, a distinct looking *Viridis* species of which fruit should be collected.

Nos. 3153, 3154, *C. viridis*.

Nos. 3158, 3167, 3169, *Ilex longipes*.

No. 3175, *Ilex lucida.*

Nos. 3168, 3145, *Ilex.* These I should think represented the same species; unless this is *Ilex monticola* I don't know it. It is desirable to get mature leaves and fruit. The shape of the leaves agrees pretty well with specimens here of *Ilex monticola* from North Carolina but their serration is rather different. I hope you have not found a new arborescent *Ilex.*

No. 3155, *C. viridis.* No. 3156, something near *C. viridis.*

No. 3172, *Leucothoë racemosa.* You have also collected this at Covington.

No. 3131, *Gaylussacia hirtella.* We have this from Ocean Springs, Mississippi.

No. 3163, *Pieris nitida.* We collected this at Hammond.

Your shrubby *Myrica* from Bogalusa is not like anything I have seen. This needs further investigation. Judging from the material in this herbarium, I should think it was an undescribed species. I am glad that it is only a shrub as *Myrica* for the new Manual will be in type in a few days.

Judging by the *Crataegus* specimens, I should not think you had been in that particular field along the railroad south of Opelousas that Harbison has always been talking about.

I hope to hear that you are coming north this summer. Won't it be necessary pretty soon to come here to elaborate your Catalogue of Louisiana plants?

210

June 27, 1919.

In this herbarium there is one specimen only of *Castanea.* This was collected by you at Covington March 28th, 1911, leaves only. It appears to be my *C. alnifolia* var. *floridana.*

Castanea pumila must be common in Louisiana as it grows at Natchez, Biloxi, Fulton on the Red River, and at many places in eastern Texas. How have we and Palmer missed it? Please tell me what you know about this tree in Louisiana.

Elwes was here four very hot days and then went to Rochester, New York, and to New York City. He sailed for home ten days ago and I suppose is now safely there. He appears to have had a very good time and to have seen much to interest him. He did not, however, seem to be much impressed with the Live Oaks, and said the largest he saw were on Avery Island where I did not see anything very large in the way of trees.

Any chance of your coming north this summer?

211

July 14, 1919.

I take much pleasure in having your name placed on the mailing list of the Journal of the Arnold Arboretum for a complimentary copy.

You will, I hope, receive the first number in the course of a few days.

212

July 17, 1919.

I have your last package of plants.

1915 may be a new variety of *Celtis pumila*, or perhaps a new species. The shape and serration of the leaves are like those of *C. occidentalis* but the pedicels are much too short.

1916, *Celtis occidentalis* [var.] *crassifolia.*

1917, *Celtis pumila.*

1918, *Vaccinium atrococcus.*

1919, *Fraxinus americana?* It is too pubescent and the leaves are not of the normal shape. Fruit of this should be collected.

1920, *Fraxinus pennsylvanica* var. *lanceolata.*

1921, *Fraxinus americana.*

1922, *Carya cordiformis.*

1923, *Vaccinium tenellum.*

The Selma region seems to be maintaining its reputation for strange trees. I am sorry to hear that you won't be here this summer.

213

August 27, 1919.

We have *Ulmus fulva* only from western Louisiana. Does it not occur east of the river?

An early answer will oblige.

214

August 29? [1919]

I thank you for your note. The right sort of things certainly have not been coming my way of late for in the last eighteen months five members of my immediate family have gone!

Fortunately I have three devoted daughters & a great deal of work to do.

215

September 2, 1919.

I have to take up *Prunus* for my new Manual now almost at once and have only unsatisfactory material and imperfect knowledge to work with.

You collected March 22d, 1911, at Natchitoches *Prunus* 6 and 7. Have you followed these up? I suspect they may be the so-called Big Tree Plum, *P. arkansana* or *P. mexicana* S. Watson. Palmer also collected a number of specimens at Natchitoches but no mature leaves or fruit. These are needed from western Louisiana. We have from you also sterile branches of the *Prunus* collected at Ruston, Louisiana. Nos. 4 and 9. August 4 and September 22, 1914, but these are only sterile branches.

You have seen, I believe, about Sardis *Prunus umbellata* with yellow fruit. I cannot make up my mind whether the red-fruited tree in Alabama and Florida which looks like *umbellata* should be considered a variety of that species or something distinct. Have you any opinion on this?

There is still for you to look up this autumn *Castanea alnifolia*, *C. floridana* from across the lake, *Quercus Cocksii*, your new *Myrica* from eastern Louisiana, and many *Crataegus* numbers.

Is n't it about time for you to begin to think about getting your catalogue ready for publication? I want to live long enough to see it.[20]

216

September 4, 1919.

I am sending you under another cover a few seeds of a Mulberry and an Elm from the Himalayas. These trees ought to succeed in New Orleans if any one can be found to plant the seeds and look after the young plants.

217

October 31, 1919.

We are sending you by parcel post two plants of *Pinus luchuensis*, eight of *Paulownia Mikado* and six of *Quercus pachyloma*. They were raised from seed collected by Wilson in Formosa and these trees ought to flourish in New Orleans. Will you find some one who will take good care of them? The *Paulownia* is described by Wilson as a magnificent flowering tree.

It is some time since I have heard from you, so I suppose you have been in the field. I hope that you raised a good crop of cotton in Alabama this year for the present price seems most encouraging.

With kind regards, I am

218

November 5, 1919.

We suspect here now that *Hamamelis virginiana* does not grow in Louisiana and that all the specimens which we have from the state should be referred to *Hamamelis vernalis* which is a winter and early spring bloomer, and differs from the northern plant which flowers in October or early November by the abundance of the stellate pubescence on the lower surface of the leaves. *Hamamelis vernalis* as I have seen it in Missouri suckers freely, spreading into large clumps, while *H. virginiana* does not sucker. The Louisiana specimens which seem to belong to *H. vernalis* are, —

Richland Parish, Cocks, April 18, 1910, "reported to bloom February and March"; Ruston, Cocks, July 1909, with a flowering branch collected February 4, 1911; Lake Charles, Cocks, March 27, 1911, Sargent, March 20, 1911; low woods, Winnfield, Sargent, April 6, 1913, October 9, 1913; low woods west of Opelousas, Sargent, April 4, 1913, "Tree 18 feet"; Butler Plantation, Sargent, April 12, 1916; Covington, Sargent, April 1, 1900, Cocks, April 14, 1914, with flowers collected December 28th, April 10, 1910, "reported flowering in January." Also the following numbers of Palmer collected in western Louisiana: 7065, 7246, 7596, 9432, 9559.

[20] Catalogue never published. A holograph ms. card file of plant names and localities dating from this period is in the Department of Botany at Tulane.

Texas and southern Mississippi specimens seem to belong to *Hamamelis vernalis*. The specimens from Louisiana in flower are very fragmentary and unsatisfactory, and I am writing you this now in the hope that you will follow up the *Hamamelis* business this autumn and winter and find out just when the Louisiana plants flower. I remember the large treelike plant west of Opelousas and if it is *H. vernalis* I am afraid this species will have to find a place in the Manual. Am I right in thinking there are large treelike specimens in eastern Louisiana?

I wish you would look out for large treelike specimens and give me their dimensions, also please notice if the suckering habit is common in Louisiana.

I suppose some sort of a *Hamamelis* grows at Sardis but there is no specimen here, and only one Alabama specimen collected by Harbison on Sand Mountain. I am afraid there is still much to learn about trees north and south.

219

November 15, 1919.

Glad to get your letter about *Hamamelis*. I am surprised that the Alabama and Louisiana trees are so large. Can't you spare me a specimen from Alabama: It is certainly curious that this winter-blooming species has been so long mistaken for *Hamamelis virginica* [sic]. I hope you can send us more and better Louisiana flowering material than we have now.

I will see what can be done about *Rosa Hugonis*. I think we can get them for you.

220

November 21, 1919.

The package of plants has arrived safely — many thanks. I am very glad to get the *Castanea* from Sardis. It is what I have called *Castanea alnifolia* var. *floridana*.

Your *Myrica* I do not know at all. As far as I can see now it looks like a new species. The black-fruited *Vaccinium* is, as you suggest, *melanocarpum*.

I am sorry you did not include a specimen of *Hamamelis* from Sardis. I am anxious to see this. Can't you help me?

221

November 25, 1919.

I hope you are going to be able to send me a specimen of *Hamamelis* from the Selma region. Possibly *Hamamelis virginiana* gets into northern Alabama but I do not feel at all sure of it, and I doubt if it is anywhere else in the Gulf States.

Mohr talks about *Hamamelis* being common all over the state of Alabama but we have only one specimen without flowers or fruit from the

state. *Hamamelis* has to go to the printer now almost at once, so I shall be glad of any help you can give me.

222

December 3, 1919.

The Alabama *Hamamelis* has arrived this morning and is the same as the Louisiana plant. I am taking up for it Pursh's name of *Hamamelis macrophylla* for it seems sufficiently distinct in its short stellate pubescence and the roughness of the leaves caused by the persistence of the bases of this pubescence. It is the only species in the Gulf States where it is apparently common and generally distributed, although it does not get far south apparently in Florida. I understand that the inner surface of the calyx is yellow in this species, like that of *H. virginiana*, and not red as in *H. vernalis*. Can you confirm this idea?

223

December 13, 1919.

By all means send me a few of your specimens of the Alabama Witch Hazel for we have very poor flowering material. I am glad to have the information about the color of the inner surface of the calyx-lobes.

224

December 18, 1919.

Here are a few *Crataegus* names for you:

Crataegus viridis Palmer, Nos. 8720, 7283, 7284, 8835, 8897, 8931, 9406, 9409, 9454.

Low woods west of Opelousas, April 4, 1913, No. 5, C. S. Sargent; near Bogalusa, Cocks, No. 3151, April 15, 1919.

East Opelousas, Cocks, April 4 and 5, 1919, Nos. 3140, 3141, 3146, 3147, 3153, 3154, 3155, 3156, 3137, 3134, 3133, 3138.

Crataegus edita, Cocks, Natchitoches, April 24, 1912, No. xvii.; Palmer Natchitoches, Nos. 7288, 8898, 9422.

Crataegus Bushii Sarg., our *Crus-galli* tree in the yard on road to English Bayou from Lake Charles; Palmer, Chopin, No. 7234 and No. 8843, Lake Charles No. 7696.

You remember the large tree of the *Viridis* Group in yard down the road from Lake Charles with twenty rose-colored anthers and dark bark. You have n't got the fruit of this and there is no other Louisiana specimen here like it. Except in some minor characters it is a good deal like *C. penita* Beadle from Chattanooga. It is also a good deal like *C.* [blank] Sarg. from Fulton, Arkansas, but it does n't have the very conspicuous tufts of hairs in the axils of the leaves of that species. On a single individual and without fruit I don't know if it is wise to say much about the Lake Charles tree which as we saw it is certainly handsome and interesting.

With the compliments of the season and all good wishes for the New Year, I am

225

December 26, 1919.

Thanks for your package of specimens. The *Castanea* from Baton Rouge is *pumila*. The Selma *Hamamelis* is interesting and I suppose is *macrophylla*, but the pubescence is different and pubescent through the season on the old leaves, so that the tubercles which are usually so prominent on the Louisiana specimens do not appear. I should be very glad to see spring or summer leaves of the Selma plant. Can you manage these?

I am particularly glad to get your Opelousas specimen of *Amelanchier canadensis* which apparently is a rare plant in western Louisiana, although common enough east of the river. Palmer never seems to have collected it, and you and I never collected it together. I have only one other western Louisiana specimen which was also collected by you. I should have supposed that Lake Charles would have been just the place for *Amelanchier*. We have no evidence that it gets to any part of southern Arkansas or that it reaches Texas. Have you ever found it further west than Opelousas? I hope you will let me know about it.

With all good wishes for the New Year, I am,

226

December 27, 1919.

I have this morning yours of the 22d. I have heard the name of Leavitt, a supposed landscape gardener, but I know nothing of his ability. Judging by others in his class, you may be expected to hear from him how to make in New Orleans a Long Island Italian garden.

As soon as I got your letter I wrote to some people in Pennsylvania who propagate *Rosa Hugonis* and asked them to send half a dozen plants to you, and I have written again today to find out why they have n't done it. When I hear from them on the subject I will communicate with you again.

I have got to Crataegus in the Manual!

227

January 2, 1920.

Conrad [i.e. Conard] & Jones, nurserymen in West Grove, Pennsylvania, tell me that some time ago they sent you two plants of *Rosa Hugonis* and later four others. Please let me know if these arrived and if they were in good condition.

The best I can do with that *Crataegus* of the *Flava* Group from West Feliciana Parish is to call it *Crataegus constans* Beadle. I should not like to swear that the determination was correct for we have no type of *C. constans* and Beadle's descriptions are rather vague but the specimens agree fairly well with his description and I don't believe you can do better than to adopt this name.

The *Crus-galli* species with yellow anthers, your No. 1008 which you say is common near Sardis, seems to be *Crataegus algens* Beadle. No one has

collected fruit from the Sardis region. Harbison's 1471 is apparently the same. The Sardis *Crus-galli* species with purple anthers from the Sardis region is evidently *C. torva*. It is Harbison's No. 1470. No fruit of this has been collected and there is no evidence here that you have collected it. The narrow-leafed *Crus-galli* species from near the quarry at Winnfield I am calling *C. Cocksii*, I hope you can bear it.

228

January 5, 1920.

Professor Wiegand, who is an authority on eastern *Amelanchiers*, saw yours from Sardis the other day and thought it was an undescribed species which he has found growing from central New York southward to Alabama. He is working on a revision of his paper on *Amelanchiers* and no doubt will have something to say about these plants in the course of time.

Crataegus is easy in comparison with *Prunus* which I am afraid is a pretty hopeless proposition. We received from you on August 20, 1918, some small light yellow plums. Is this your No. 36, a leaf specimen with one fruit on it which, however, looks much larger than that received on August 20. No. 36 looks like Hederick's [= Hedrick's] *angustifolia* var. *varians*. If this is a good guess, then I suppose No. 36 is an introduced or escaped plant. Indeed all the *angustifolias* must be that as apparently it does not grow wild anywhere east of the Mississippi River.

Let me hear anything you have to say about plums at your early convenience.

229

January 11, 1920.

We have no specimen of *Crataegus opaca* (*aestivalis*) from eastern Louisiana. Have you ever found it there and where? It grows near Mobile and at Meridian and at Hattiesburg, Mississippi, and, as you know, it is very common all over western Louisiana.

230

February 16, 1920.

Hooker mentions without description a *Pyrus arbutifolia macrophylla* as collected by Drummond at New Orleans and Covington. Do you know any large-leaved *Aronia* in Louisiana? In this herbarium there is no specimen at all of *Aronia* from eastern Louisiana. I do not know how we could have missed it at Covington. If you have Covington specimens with large leaves I wish you would let us see one of these at once. Palmer collected in St. Augustine County, Texas, a large-leaved, red-fruited *Aronia* which he describes as a tree twenty feet high. The size of the leaves would agree with Hooker's name. The question is, is there a large-leaved variety treelike in habit in Covington or in the neighborhood of New Orleans.

Your specimen of *Aronia arbutifolia* collected at Deridder April 5, 1912,

is typical. We collected the same thing at Winnfield and I collected it at Biloxi when I was last there.

We are having a terrible winter and are so buried in snow that it is almost impossible to get about. I hope you are well.

231

February 23, 1920.

I don't make anything out of *Fraxinus Darlingtonii* which I fancy is nothing but *Fraxinus pennsylvanica*. Britton described a large number of Ash trees, but according to our ideas here none of them have any standing. *Fraxinus pauciflora* Nuttall is the correct name of *Fraxinus floridana* of my Manual. We have here a specimen collected by Fendler at New Orleans April 1848 consisting of a single leaf and a cluster of fruit about two-thirds grown. The specimen is not satisfactory but I think it is *F. pauciflora* which I hope you will rediscover. Except for this specimen I have no indication that this Ash grows anywhere west of the Appalachicola River in Florida.

I hope you will look further for *Aronia* in the Covington region and make us some specimens. I will try and get from Kew photographs of the specimens collected by Drummond in Louisiana.

232

March 1, 1920.

We have here no specimen of *Crataegus spathulata* from eastern Louisiana. Have you ever found it there? As it grows near Natchez it might be expected in West Feliciana Parish. It does not appear to be in southern Mississippi, and it is, as you know, fairly common in the Red River Valley in Louisiana.

An early answer will oblige.

233

March 2, 1920.

We have placed your Alabama *Fraxinus* No. 946 with *pennsylvanica* var. *lanceolata*. The distinctly acuminate fruit is unusual, although we have the specimens from Mississippi with similar fruit. I do not believe there is any doubt, however, about the species. I should think that *Fraxinus caroliniana* might grow in the Selma region but apparently you have n't collected it there. I am glad to hear you are starting out again for *Crataegus*.

It does n't look very much like spring in these parts for there are still about three feet of snow on the ground and the thermometer on the 1st of March was several degrees below zero. We do not remember to have had a winter like this before.

234

March 6, 1920.

We have no specimen of *Crataegus apiifolia* from eastern Louisiana. It

must grow there I should think, certainly in West Feliciana as it seems to be common about Natchez. Can't you send us a specimen?

We seem much less well provided with eastern Louisiana plants than with those from west of the river.

The worst snow-storm of the year is going on today.

235

March 9, 1920.

I am glad to hear that *Crataegus spathulata* is common in eastern Louisiana, but how did you expect me to know it if you never sent me a specimen from that part of the state? I certainly do not remember to have seen it there myself. We are very short here of eastern Louisiana material and I wish we had more of it.

236

March 10, 1920.

From eastern Louisiana our only specimen of *Acer floridanum* was collected by us April 12, 1916, at the Dessert Plantation near Bayou Sara and called *Acer saccharum*. Our only other Louisiana specimens are from Natchitoches. I hope you will be able this spring to more fully locate this tree in Louisiana. It is probably common in some parts of the state.

Acer saccharum var. *glaucum* as a Louisiana tree does not seem to be very well known. The only Louisiana specimen we have here is your No. 2520, St. Francisville, May 15, 1915, and doubtfully referred by you to *A. floridanum*. This is another tree which I hope you will follow up this spring as there is no reason why it should not be common in Louisiana.

237

March 15, 1920.

The books talk about *Halesia tetraptera* in Louisiana and Texas. This certainly must be a mistake. The only indication we have that this tree grows west of the Mississippi River is one specimen collected in Arkansas by Palmer. We have no specimen from Florida or Mississippi and only one from Alabama and that of course is from Selma, a region in which for some unknown reason so many northern plants find conditions suitable for them. The common east Gulf States species with four-winged fruit is *Halesia parviflora* which is evidently much more abundant than I had supposed and grows into a small tree. This form is also at Selma; it grows at Laurel, Mississippi, and it would not therefore be very surprising if it got into Louisiana.

Britton claims that his *Fraxinus Smallii* and *F. Darlingtoniana* [*darlingtonii*] grow in Louisiana. These we take it are only forms of the Red Ash, *Fraxinus pennsylvanica*, and there is no indication here that this tree gets into Louisiana at all. Have you ever found it there? It is a tree certainly to be looked for, and if you can find it this spring it will be quite an assistance to me as I must now take up *Fraxinus* and *Halesia* for my Manual very soon.

Rehder has gone to New York today to look up some things in the herbarium of the New York Botanic Garden and I have asked him to see if he can find evidence there of Britton's species of *Fraxinus* growing in Louisiana.

238

March 18, 1920.

Rehder is back from his trip to New York and reports the only Louisiana specimen of any of Britton's new Ashes is one called there *Fraxinus Darlingtonii*, a single specimen collected by C. R. Ball at Gretna across the River from New Orleans. This is perfectly glabrous and the ordinary form of the Green Ash, so I do not think that *Fraxinus Darlingtonii* need bother you except as a synonym.

Bumelia cassinifolia is based on a single fragmentary specimen collected by Bush near Opelousas. This is all the material that there is in New York. We have a photograph of the type specimen with a single leaf which we should be glad to lend you if you care to see it. I do not believe there is anything in it however. They certainly have a talent in New York for making trouble.

[*To be concluded*]

NOMENCLATURAL NOTES ON DIPSACUS FULLONUM AND DIPSACUS SATIVUS [1]

I. K. FERGUSON AND GEORGE K. BRIZICKY

WHILE ONE OF US was preparing an account of the Dipsacaceae for a generic flora of the southeastern United States (Ferguson, Jour. Arnold Arb. **46**: 226–231. 1965), it was found that the name *Dipsacus fullonum* had been and is still being used by a number of authors in different ways and that the combination *D. sativus* has been attributed to several different authors. It seems desirable to review these problems, in the hope of resolving the confusion surrounding the usage and typification of *D. fullonum* and the authority for the combination *D. sativus*.

DIPSACUS FULLONUM

The name *Dipsacus fullonum* has been used in at least two ways. Some authors have applied the name to the wild teasel, which has erect receptacular bracts; the cultivated teasel, which has recurved receptacular bracts, is then referred to as *D. sativus*. Among the workers who have adopted this treatment are F. A. Scholler (Fl. Barbiensis 47. 1775), C. Schkuhr (Bot. Handb. 1: 67. 1791), N. E. Brown (English Botany, ed. 3. Supplement. 197, 198. 1892), E. de Halácsy (Consp. Fl. Graec. 1: 757. 1901), F. N. Williams (Prodr. Fl. Brit. 1: 201. 1903), E. G. Bobrov (Fl. URSS 24: 21–23. 1957), and, most recently, A. R. Clapham (in Clapham, Tutin, & Warburg, Fl. Brit. Isles, ed. 2. 797. 1962). Numerous other authors, including, it appears, all American workers, have applied the epithet "*fullonum*" to the cultivated teasel and the name *D. sylvestris* Hudson to the wild plant.

A number of authors have commented on the different usages of the name *Dipsacus fullonum*. Brown, Williams, and Bobrov (see references cited above) have each pointed out that the name has been misapplied, maintaining that Linnaeus intended the epithet "*fullonum*" to refer to the wild plant. Arthur Cronquist (in Hitchcock, Cronquist, Ownbey, & Thompson, Vasc. Pl. Pacif. NW. **4**: 480, 481. 1959), although referring to the wild teasel as *D. fullonum* subsp. *sylvestris*, has observed that *D. fullonum* could be typified by the wild plant. He says, "The weight of historical practice, however, has been to accept the more logical, if perhaps less legally proper typification of Hudson, who in 1762 considered the two

[1] Continuing a series of miscellaneous notes and papers on the flora of the southeastern United States made possible through the support of George R. Cooley and a grant from the National Science Foundation. The authors are indebted to Carroll E. Wood, Jr., for his valuable advice and suggestions.

phases to represent different species and restricted the name *D. fullonum* L. to the cultivated plant with recurved receptacular bracts."

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Most subsequent authors have recognized the wild teasel, with erect receptacular bracts, and the cultivated teasel, with recurved bracts, as distinct species or subspecies and have interpreted *D. fullonum* in either of two ways: (1) as represented by the specimen in the Linnaean Herbarium, which is the wild plant with erect receptacular bracts and which is labeled "*fullonum*" in Linnaeus' handwriting, or (2) by following Hudson's treatment and adopting the epithet "*fullonum*" for the cultivated plant with recurved receptacular bracts.

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NOMENCLATURAL NOTES ON DIPSACUS FULLONUM AND DIPSACUS SATIVUS [1]

I. K. FERGUSON AND GEORGE K. BRIZICKY

WHILE ONE OF US was preparing an account of the Dipsacaceae for a generic flora of the southeastern United States (Ferguson, Jour. Arnold Arb. **46**: 226–231. 1965), it was found that the name *Dipsacus fullonum* had been and is still being used by a number of authors in different ways and that the combination *D. sativus* has been attributed to several different authors. It seems desirable to review these problems, in the hope of resolving the confusion surrounding the usage and typification of *D. fullonum* and the authority for the combination *D. sativus*.

DIPSACUS FULLONUM

The name *Dipsacus fullonum* has been used in at least two ways. Some authors have applied the name to the wild teasel, which has erect receptacular bracts; the cultivated teasel, which has recurved receptacular bracts, is then referred to as *D. sativus*. Among the workers who have adopted this treatment are F. A. Scholler (Fl. Barbiensis 47. 1775), C. Schkuhr (Bot. Handb. 1: 67. 1791), N. E. Brown (English Botany, ed. 3. Supplement. 197, 198. 1892), E. de Halácsy (Consp. Fl. Graec. 1: 757. 1901), F. N. Williams (Prodr. Fl. Brit. 1: 201. 1903), E. G. Bobrov (Fl. URSS **24**: 21–23. 1957), and, most recently, A. R. Clapham (in Clapham, Tutin, & Warburg, Fl. Brit. Isles, ed. 2. 797. 1962). Numerous other authors, including, it appears, all American workers, have applied the epithet "*fullonum*" to the cultivated teasel and the name *D. sylvestris* Hudson to the wild plant.

A number of authors have commented on the different usages of the name *Dipsacus fullonum*. Brown, Williams, and Bobrov (see references cited above) have each pointed out that the name has been misapplied, maintaining that Linnaeus intended the epithet "*fullonum*" to refer to the wild plant. Arthur Cronquist (in Hitchcock, Cronquist, Ownbey, & Thompson, Vasc. Pl. Pacif. NW. **4**: 480, 481. 1959), although referring to the wild teasel as *D. fullonum* subsp. *sylvestris*, has observed that *D. fullonum* could be typified by the wild plant. He says, "The weight of historical practice, however, has been to accept the more logical, if perhaps less legally proper typification of Hudson, who in 1762 considered the two

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Hort, The "Critica Botanica" of Linnaeus, English translation, 203. 1938), and Stearn in his introduction to the Ray Society facsimile of *Species Plantarum* (90, 93. 1957) has stated, that where a variety has been described within a species the typical element refers to the wild form, "the natural species," "natural form," "natural plant," or "normal form" of Linnaeus. This appears to be the usage that Linnaeus adopted in *Hortus Cliffortianus* (29, 30. 1737), where the first species described, *Dipsacus capitulis florum conicis*, consists of a typical element and three varieties (α, β, γ). The phrase name and synonymy of the typical element correspond to those of *D. fullonum* in *Species Plantarum*, and the phrase name and synonymy of var. γ correspond to var. β of *Species Plantarum*. At the end of the description is the observation, "Planta naturalis gaudet paleis calycinis, flosculos distinguentibus, fere erectis & mollibus; varietas autem (β) paleis parum reflexis & rigidiusculis; haec autem (γ) paleis apice reflexis, duris & hamatis; ista autem (α) foliis caulinis incisis a naturali differt planta."

It appears to be in agreement with Linnaeus' concept of species to regard the wild plant as the typical element of *Dipsacus fullonum*. This treatment also appears to be consistent with the International Code of Botanical Nomenclature (65. 1961): "In choosing a lectotype, any indication of intent by the author of a name should be given preference unless such indication is contrary to the protologue" and "If it can be shown that the element best fitting the protologue has been removed, it should be restored and treated as the lectotype." We are thus in agreement with those who apply the name *Dipsacus fullonum* to the wild teasel with erect receptacular bracts. In this circumstance Linnaeus' specimen of the wild teasel with erect receptacular bracts and labeled "*fullonum*" in Linnaeus' handwriting (Linnaean Herbarium, sheet 119.1) should be taken as the lectotype. The cultivated plant then bears the name *D. sativus*, if it is regarded as a distinct species.

DIPSACUS SATIVUS

Further confusion exists concerning the author responsible for the elevation of var. *sativus* to specific rank. A number of different authors, including F. A. Garsault (Fig. Pl. Anim. 2: *tab. 249.* 1764, and Traité Pl. Anim. 2: 160. 1767) have been credited with making the combination. Since Garsault did not consistently use binomials in these works, the combination can not be considered to have been published validly by him. The combination has also been erroneously attributed to F. A. Scholler (Fl. Barbiensis 47. 1775), who mentioned the name only incidentally under *Dipsacus fullonum*. Most authors have attributed the combination *D. sativus* to G. A. Honckeny (Vollst. Syst. Verz. Gewächse Teutschl. 1782). Jackson (Index Kewensis), Schinz & Thellung, and Mansfeld (see references cited under *D. fullonum*) cite p. 374 for the combination, while Bobrov (Flora URSS) gives p. 16. It has developed that Honckeny did indeed make the combination *D. sativus*

validly on page 374 of his very rare work of 1782,[2] although he later referred (Syn. Pl. Germania 2: 6.1792) to the cultivated teasel as *D. fullonum* and cited *D. sativus* C. Bauh. in synonymy, making no reference to his earlier work.

Several modern authors, including Clapham (*loc. cit.*) and Cronquist (*loc. cit.*) have treated the two elements of *D. fullonum* as subspecies. The correct subspecific combination *D. fullonum* L. subsp. *sativus* does not yet appear to have been published properly. Clapham cited Thellung as authority, but Thellung (Fl. Advent. Montpellier 490, 491, 680, 697. 1912) did not make this combination, although he suggested that *D. sativus* may perhaps be a subspecies of *D. fullonum* and included the epithet "*sativus*" in the index to his work at both specific and subspecific rank. Clapham can not be considered to have made a formal new combination either, for he does not cite the complete reference to the basionym as required by Art. 33, International Code of Botanical Nomenclature, 1961.

In conclusion, it appears that the nomenclature of these two species of *Dipsacus* may be summarized as follows:

Dipsacus fullonum Linnaeus, Sp. Pl. 1: 97. 1753.

D. sylvestris Hudson, Fl. Anglica 49. 1762; Fernald, Gray's Man. Bot. ed. 8. 1347. 1950; Gleason, New Britton & Brown Illus. Fl. NE. U.S. 3: 309. 1951; Cronquist, Vasc. Pl. Pacif. NW. 4: 480. 1959.

Dipsacus sativus (L.) Honckeny, Vollst. Syst. Verz. Gewächse Teutschl. 1: 374. 1782.

D. fullonum β Linnaeus, Sp. Pl. 1: 97. 1753.
D. fullonum β *sativus* Linnaeus, Sp. Pl. ed. 2. 2: 1677. 1763.
D. fullonum, sensu Hudson, Fl. Anglica 49. 1762, and many other authors, including all American workers.

[2] The authors wish to acknowledge the assistance of Mrs. Lazella Schwarten, Librarian of the Arnold Arboretum and of the Gray Herbarium, and that of Dr. R. K. Brummitt, Royal Botanic Gardens, Kew, for their help in trying to locate a copy of Honckeny's *Vollständiges systematisches Verzeichniss aller Gewächse Teutschlandes*. We are especially grateful to Professor K. H. Rechinger, Naturhistorisches Museum, Wien, who found a copy of this elusive work in the Austrian National Library and sent a photostat of the pages pertaining to *Dipsacus* (372–378).

In an earlier paper (Ferguson, Jour. Arnold Arb. 46: 229. 1965) C. Schkuhr (Bot. Handb. 1: 67. 1791) is incorrectly cited as the authority for the combination *Dipsacus sativus*, for at that time the synonymy in Honckeny's work of 1792 suggested that he had not made the combination earlier.

THE RUBIACEOUS GENUS MUSSAENDA: A NEW SPECIES FROM NORTH BURMA

DON M. A. JAYAWEERA

IN AN EARLIER PAPER [1] the species of *Mussaenda* of India and Ceylon were treated in some detail. Since completion of that study there has come to my attention the new species described here which I am glad to name after its collector, the renowned plant explorer and author, Francis Kingdon-Ward, F. L. S.

Mussaenda Kingdon-wardii, sp. nov.

Frutex, ramis parce erectis, pubescentibus, foliis apicem versus aggregatis; foliis oppositis, coriaceis, lineari-lanceolatis, 5.5–10 cm. longis, 0.8–1.6 cm. latis, utrinque attenuatis, apice acuminatis, basi in petiolum canaliculatum, hirsutum, 0.5–1 cm. longum, attenuatis; laminae facie supra glabra, infra venis prominentibus pubescentibusque ornata; stipulis parvis, 5–7.5 mm. longis, 3–4 mm. latis, late triangulari-lanceolatis, apice usque ad medium divaricato-bifidis, extus in medio et marginibus pubescentibus, intus glabris excepto supra basin et inter glandulas. Inflorescentiae terminales, pauciflorae, cymosae; bracteis lanceolatis, 5.5 mm. longis, acuminatis, extus pubescentibus, intus glabris; floribus tubulosis, aurantiacis, pedicellis rigidis, pubescentibus, quam ovariis brevioribus; calyce 5-lobato, parvo, lanceolato-acuminato, 4–4.5 mm. longo extus hirsuto, intus ad basin loborum glandulis geminis donato; sepalo petaloideo albo, ovato, 3–3.5 cm. longo, 2 cm. lato, apice acuto, basi cuneato, utrinque glabro, excepto venis principalibus marginibusque, "petiolo" 1.5 cm. longo, pubescenti; tubulo corollae extus pubescenti, intus basin versus glabro; lobis corollae et staminibus non visis; ovario inferiori, 3.2 mm. longi, obconico-fusiformi, 2-loculari, placentis pulviniformibus axillaribusque. Stylus stigmaque etiam non visi; fructibus subglobosis, 8 mm. longis, 6 mm. latis, lenticellatis, parce pubescentibus, lobis calycis deciduis; seminibus minutis, reticulatis, oblongis vel ovoideis, sine spinulis, 0.7–0.8 mm. longis.

Shrub with somewhat erect pubescent branches bearing leaves clustered towards their apices. Leaves opposite, leathery, linear-lanceolate, acuminate, attenuate at base, 5.5–10 cm. long, 0.8–1.6 cm. broad, glabrous on the upper surface, pubescent on veins and venules below, the 8 or 9 pairs of veins prominent on the lower surface and arcuate; petiole 0.5–1 cm. long, hirsute and grooved along the upper surface. Stipules small, 5–7.5

[1] The rubiaceous genus Mussaenda: the species of India and Ceylon. Jour. Arnold Arb. **44**: 232–267. 1963.

mm. long, 3–4 mm. broad at the base, triangular-lanceolate, bifid about the upper half of their length, the rami diverging, pubescent on the outer surface along the center and the margin, glabrous within except at the base and among the glands. Inflorescence a terminal, few flowered, dichotomous cyme; bracts lanceolate, 5.5 mm. long, acuminate and hairy on the outer surface, glabrous within. Flowers tubular, orange, on stout

FIG. 1. **Mussaenda Kingdon-wardii:** A, branch with leaves and petaloid sepals × ½; B, stipule seen from abaxial surface × 4½; C, same as B from adaxial surface showing glands and hairs × 4½; D, bract × 3½; E, calyx lobes from within, × 3½; F, young and mature berries × ½; G, seed showing the areoles and foveae of the testa, × 20, all from *Kingdon-Ward 21707* (BM).

pubescent pedicels shorter than the ovaries. Calyx lobes 5, small, lance-acuminate, 4–4.5 mm. long, hairy on the outer surface and with one or two pairs of glands at the base of each, inside; petaloid sepal white, ovate, 3–3.5 cm. long, 2 cm. broad, acute at apex, cuneate at base, glabrous on both surfaces except along the main veins and the margins, "petiole" 1.5 cm. long, pubescent. Corolla tube pubescent on the outer surface, glabrous within towards the base; corolla lobes and stamens not seen. Ovary inferior, 3.2 mm. long, obconic-fusiform, pubescent, 2-locular with numerous ovules on cushion-shaped axile placentae; style and stigma not seen. Berry spherical, 8 mm. long, 6 mm. broad, lenticellate, scantily pubescent, calyx lobes deciduous; seeds minute, not spiny-reticulate, oblong or ovoid, 0.7–0.8 mm. long with 6–12 foveae in each areole of the testa.

DISTRIBUTION. *Mussaenda Kingdon-wardii* is an endemic species which grows in thickets along the river bed below the high water mark southeast of Sumprabum, at an elevation of 300–400 m. above sea level.

The type collection of *Mussaenda Kingdon-wardii* consists of two sheets. The holotype (BM) has two specimens, one in flower but flowers not available for examination, excepting the lower part of one flower, and the other in fruit; the isotype (A) is in fruit only. Only one collection seems to have been made of this species. It resembles *Mussaenda glabra* var. *2* of Hooker but the leaves are coriaceous and scantily pubescent. *Mussaenda Kingdon-wardii* is easily distinguished from other species of the genus by its linear-lanceolate leaves which are glabrous and shining above and pubescent on veins beneath, and by its small, scantily pubescent, lenticellate berries with dehiscent calyx.

I am very grateful to the Keeper of Botany, British Museum (Natural History), South Kensington, and to the Curator, herbarium of the Arnold Arboretum of Harvard University, for the loan of specimens in their charge for this study.

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POLLEN MORPHOLOGY IN THE JUGLANDACEAE, II: SURVEY OF THE FAMILY

DONALD R. WHITEHEAD

THE GEOLOGIC HISTORY OF THE JUGLANDACEAE is both extensive and diversified. The fossil record of the family, based on megafossils and pollen, extends through the Tertiary into the Cretaceous, includes virtually all extant genera and several extinct ones as well, and embraces geographic areas from which the family is either now absent or represented by relatively few taxa. In western North America, for example, relatively few members of the family are indigenous, yet during the Tertiary species of *Carya*, *Engelhardia*, *Juglans*, *Platycarya*, and *Pterocarya* occurred. The same applies to other regions. It is clear that juglandaceous species were important constituents of the Tertiary forests.

The available pollen morphological studies suggest that grains of most genera are distinguishable. A recent investigation has suggested that specific identifications of Pleistocene grains may be possible in some cases (Whitehead, 1963). However, there are indications of a variational continuum (for pore number and pore location) between *Pterocarya* and *Juglans* and it is conceivable that in extreme cases the separation of *Carya* and *Engelhardia* might prove difficult. Too few data on variation are available to permit a proper analysis of such problems.

Stachurska (1961) has contributed new information on pollen morphology in the family and has suggested some possible subdivisions of various pollen types. It is evident from her study that there is considerable overlap between *Juglans* and *Pterocarya* and that the identification of individual grains might prove difficult. However, the utility of the paper is severely limited by her failure to employ oil immersion optics (thus preventing any consideration of fine structure or sculpture) and her use of glycerine-jelly as a mounting medium (resulting in anomalous size measurements). In addition, a number of critical genera and species were not studied. As a consequence, the reliability of some of the observations and generalizations is questionable. More careful studies embracing a greater range of material appear to be needed.

The present study of the family was initiated with the above considerations in mind. The material studied includes two species of *Alfaroa*,

seven species of *Engelhardia*, the one species of *Platycarya*, 14 species of *Carya*, seven species of *Pterocarya*, and 16 species of *Juglans*. Several varieties of some species were studied. In general, from one to three collections were obtained for each species. More detailed studies of pollen size and pore number variation in several taxa have been carried out and discussed in a previous paper (Whitehead, 1963).

The author wishes to express his thanks to Dr. Elso S. Barghoorn who first suggested the study and gave many valuable suggestions and to Dr. Cortez Hoskins for his helpful comments on a preliminary draft of the manuscript. The writer is especially indebted to the directors of the Arnold Arboretum (A) and the Gray Herbarium (GH) for permission to collect staminate material. Additional collections were provided by Dr. Wayne E. Manning and Dr. Donald E. Stone. Slides available in the reference collection of the Geological Survey of Denmark (DGU) were studied as well. The Jersey Production Research Company kindly granted permission to publish the results of the investigation, part of which was carried out while the writer was employed as a consultant. The author is deeply grateful to Dr. Johannes Iversen and his colleagues of the Geological Survey of Denmark for permission to use the facilities of their institute and for many stimulating discussions concerning the paper. Special thanks are due to Drs. Stone and Manning for their extraordinarily careful criticism of the penultimate draft of the manuscript. Support for the final phase of the project has been provided by Grant G-17277 from the National Science Foundation.

METHODS

Whole mounts of pollen grains were prepared as outlined previously (Whitehead, 1963; treatment with KOH, acetolysis, and mounting in silicone oil). Choice of techniques was predicated on the considerations discussed by Christensen (1946), Andersen (1960), and Whitehead (1962, 1964).

Pollen size measurements for *Carya, Juglans*, and *Pterocarya* were carried out with a high-dry objective (ocular interval = 2.04 micra). Measurements for *Alfaroa*, *Engelhardia*, and *Platycarya* were made with oil immersion (ocular interval = 0.82 micra). Fifty measurements were obtained for each collection. Pore number and frequency of heteropolar grains were noted for *Juglans* and *Pterocarya*.

Of the slides available in the pollen reference collection of the Geological Survey of Denmark, only preparations in silicone oil or Tangelfoot medium were selected for study (grains mounted in Tangelfoot are identical in size to those mounted in silicone oil (Andersen, 1960)). Supplementary data on *Carya* and *Juglans* have been obtained through the courtesy of Dr. Svend Th. Andersen, who, in collaboration with Dr. Stanley A. Cain, has accumulated a number of observations on the North American species of these genera. Andersen and Cain's data were derived from pollen prepared by acetolysis (2 minutes) and mounted in glycerine-

jelly (Andersen, personal communication), hence direct size comparisons must be made with caution. However, the nearly perfect concordance of these data with those obtained by the author (see TABLE 4) suggests that the measurements from glycerine-jelly preparations may be divided by 1.06 for direct comparison. This corresponds to the correction factor of 1.15 determined by Faegri and Iversen (1964, pages 169–170).

THE PROBLEM OF POLLEN SIZE

It is evident that a variety of factors, both genetic and environmental, operate in concert to influence the size of modern pollen grains. It then follows that to obtain meaningful data on pollen size one must accumulate measurements from a number of collections distributed over the geographic range of the species and encompassing the diversity of ecological situations in which it occurs. This also will help minimize the effects of climatically aberrant years. As some of the pollen size data presented in this study involve only one or two collections, they must be considered preliminary and not necessarily characteristic for the particular species. The same reservation applies to the data on pore number for *Juglans* and *Pterocarya*.

The size data presented in this investigation will doubtless be compared with those of Erdtman (1943, 1952), Heimsch (1944), Wodehouse (1935), Stachurska (1961), Stone (1963), and others, thus it is important to note that such comparisons must be made with extreme caution. The studies of Christensen (1946) and Andersen (1960) demonstrate clearly the effect of both chemical treatment and mounting medium on pollen size and indicate that direct comparisons are possible only when identical techniques have been employed. For example, the measurements of Stachurska (1961) are systematically larger than those presented in the present study, as she employed acetolysis and mounted the grains in glycerine-jelly.

It should be emphasized that for size studies a medium in which pollen size is stabilized must be employed. Glycerine-jelly is not to be recommended. The unpredictable swelling of grains in this medium is well known (e.g., Christensen, 1946; Andersen, 1960; Cushing, 1961; Faegri & Deuse, 1960). This is demonstrated by the lack of correspondence between many of Stachurska's measurements (e.g., those for *Carya ovalis*) and those of Andersen and Cain, Stone (1963), and the writer.

The application of size-frequency data from modern pollen to the identification of fossil pollen involves even more complex considerations. Seldom can direct size comparisons be made between modern and fossil grains. The environment of preservation seems to alter the exine of fossil grains chemically so that it does not respond to treatment in the same manner as modern pollen (Christensen, 1946; Buell, 1946). Furthermore, as Andersen (1960) has indicated, pollen grains of a given species differ in size depending upon the type of sediment in which they have been preserved. Grains are apparently smallest in calcareous sediments and largest in more acid types. Consequently, it is often impossible to make

direct size comparisons between fossil grains from different levels of the same core. These various factors must be considered carefully in any application of pollen size data.

POLLEN MORPHOLOGY

Alfaroa

The pollen grains of *Alfaroa* (TEXT-FIGURES 1–6) are tectate, triporate (occasionally with two, four, and five pores), suboblate, subtriangular (rounded triangular) in polar view, and possess a fine, even, scabrate sculpture. The pores are equatorial in position and may be very slightly aspidate. The pore vestibulum is an open, low cone defined by the endexine which stops approximately two to three micra short of the pore aperture (exopore) leaving a low, ill-defined rim (TEXT-FIGURES 3 and 5). The ektexine thickens very slightly at the pore. The pore aperture is 2 to 3 micra in diameter and somewhat variable in shape. According to Erdtman (1952) the exopore is meridionally elongated, while in the collections studied by the writer it was more or less circular.

The ektexine is mostly homogeneous, consisting of a relatively thick tectum and a much reduced columella layer. The extent of the foot layer is not known. Columellae are discernible within the vestibulum, where they are visible in optical section (oil immersion only). They are relatively tightly packed and somewhat irregular in distribution. The pattern is best seen with phase contrast. It is apparent that the ektexinous thickening of vestibulum involves columella layer more than the tectum. Columellae could not be differentiated outside of the vestibulum.

The grains studied varied in size from 18.6 to 28.4 micra, with a mean of 23.5 (TABLE 1). This corresponds well to the sizes reported by Erdtman (1952) and Heimsch (1944). The exine is approximately 1.6 micra thick, of which the endexine (and foot layer?) contributes less than 0.5 micra. The exine appears to be relatively uniform in thickness over the entire surface of the grain (except surrounding the pore) in contrast to *Juglans* and *Carya* in which a distinct thinning of the exine occurs on the proximal pole. The scabrate sculpture, consisting of evenly spaced elements (less than 0.4 micra in diameter) is present over the entire surface of the grain, including the vestibulum. It is probable that the individual sculptural elements are actually micro-echinae (fine spines) comparable to those observed recently with electron microscopy in *Juglans* and *Carya* (Stone *et al.*, 1964).

In the collection of *A. costaricensis* upon which Heimsch (1944) has reported, 66 per cent of the grains were triporate, 34 per cent tetraporate, and less than 1 per cent pentaporate. However, in only one of the collections which the present writer studied (*A. costaricensis* var. *costaricensis*, *Skutch 4684*) were numbers of tetraporate grains encountered and this was clearly an aberrant collection, as the fourth pore was always polar rather than equatorial in position. Diporate and tetraporate grains were extremely rare in the other collections studied.

TABLE 1. **Pollen-Size in Alfaroa**

SPECIES	DATA FROM PRESENT STUDY * $\bar{X}$ (μ)	DATA FROM PRESENT STUDY * RANGE (μ)	STACHURSKA (1961) RANGE (μ)
A. costaricensis	23.0	20.5–26.2	
var. *elongata*	23.0	20.3–26.1	
A. costaricensis			
var. *costaricensis*	24.5	18.6–28.4	No data
A. manningii	23.4	20.3–26.1	
	23.5	18.6–28.4	

* n = 50 for each collection

No significant interspecific (between *A. costaricensis* and *A. manningii*) or intervarietal pollen morphological differences were noted.

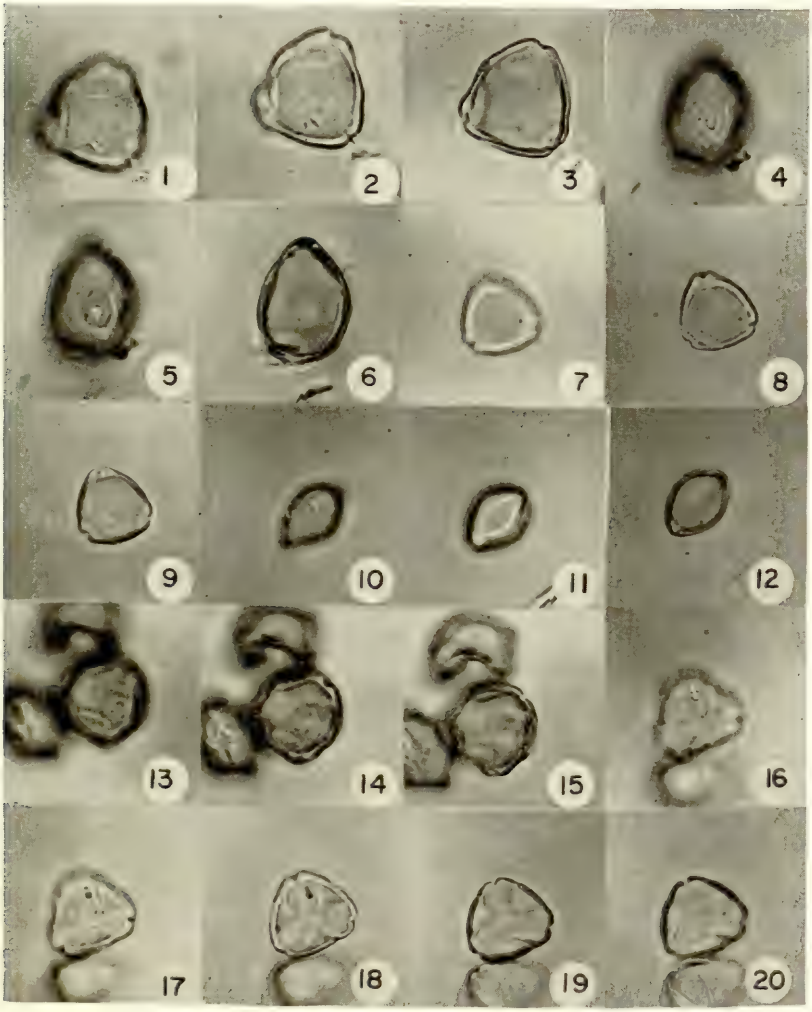
Specimen citations are given at the end of the paper.

Engelhardia [1]

The pollen grains of *Engelhardia* are tectate, triporate (occasionally diporate, tetraporate and pentaporate), suboblate to oblate in shape, triangular to rounded-triangular in polar view, and possess a fine, even scabrate sculpture. Erdtman (1943, page 106) refers to the sculpture of *E. chrysolepis* as "faintly reticulate," but this represents a misinterpretation. The pores are equatorial in position and may be very slightly aspidate (TEXT-FIGURES 7–15, 105). The vestibulum is similar to *Alfaroa* (see TEXT-FIGURES 8–10), although in some collections (and species?) it cannot be differentiated clearly. The ektexine thickens slightly within the vestibulum in grains of *E. nudiflora* and not at all in *E. chrysolepis*. In the latter species (TEXT-FIGURE 10) the endopore is elongated equatorially (this is partly a function of the oblate shape of the grains), while in others it is more or less circular. The exopore (pore aperture) varies in shape from elongated (*E. chrysolepis*) to circular in outline.

The exine is similar to *Alfaroa*, with some variation from species to species. In *Engelhardia chrysolepis* it is relatively thin, homogeneous (columellae not distinguishable), and does not thicken at the pore. By contrast, grains of *E. nudiflora* and *E. pterocarpa* are much like those of *Alfaroa*; columellae are discernible in the thickened ektexine near the pore. In most collections of *E. spicata*, *E. parvifolia*, and *E. apoensis* a rather curious exine structure was encountered (TEXT-FIGURES 13–15); the exine appears to undulate sharply giving the grains a distinctly crumpled appearance. At first it was thought that this merely represented a structural anomaly, either a function of immature grains or of faulty preparation. However, the uniformity of the feature, its appearance in other collections of *E. spicata* and *E. parvifolia*, and the observation of

[1] The spelling used here, *Engelhardia*, is the original spelling, although authors in general have used *Engelhardtia*, as incorrectly cited in Index Kewensis. See also Manning, Am. Jour. Bot. **49**: 975. 1962.



TEXT-FIGURES 1–20. Magnification 690 ×. Each series (e.g., 1–3) represents successively lower levels of focus. 1–6. *Alfaroa costaricensis* var. *elongata*, polar view (1–3), equatorial view (4–6). 7–12. *Engelhardia chrysolepis*, polar view (7–9), equatorial view (10–12). 13–15. *Engelhardia spicata*, polar view of "crumpled" grains. 16–20. *Platycarya strobilacea*, polar view.

similar morphology in the same species by Stachurska (1961), suggests that it may represent a regular structural feature with some taxonomic significance. In some of these grains it is possible to see that the exine is unevenly thickened. It seems likely that the thickened regions represent the "ridges" of the crumpled grains and the thinner areas the concavities. In some (but not all) grains it is possible to observe that columellae are present along the "ridges" (TEXT-FIGURE 105) but not on the concave

TABLE 2. **Pollen-Size in Engelhardia**

SPECIES	DATA FROM PRESENT STUDY * $\bar{X}$ (μ)	DATA FROM PRESENT STUDY * RANGE (μ)	STACHURSKA (1961) RANGE (μ)
§ ENGELHARDIA			
E. apoensis ***	17.8	15.1–20.3	
E. nudiflora	18.9	16.8–20.8	
E. parvifolia **	20.3	17.2–23.0	19.6–24.9
E. serrata var. *cambodica*	20.9	18.9–23.8	
E. spicata var. (?) ***	21.9	19.2–24.0	19.6–24.9 15.7–22.7
E. spicata var. *acerifolia* ***	19.6	16.8–20.8	19.2–24.5
E. spicata var. *colebrookiana* **	22.0	20.0–24.8	21.0–31.5
§ PSILOCARPEAE			
E. roxburghiana	14.8 †	12.8–17.4 †	14.2–17.3
§ OREOMUNNEA			
E. pterocarpa	20.5	18.0–23.2	

* n = 50 for each collection
** forms with irregularly thickened exine occasional
*** forms with irregularly thickened exine predominant
† average of three collections

surfaces. This would suggest that the feature is due to an uneven thickening of the columella layer. Since the scabrate sculpture is present even on the concavities it is apparent that at least some tectum is present.

Individual grains of *Engelhardia* vary in size from 12.8 micra (*E. chrysolepis*, $\bar{X} = 14.8\mu$) to 24.8μ (*E. spicata* var. *colebrookiana*, $\bar{X} = 22.0\mu$) (TABLE 2). The exine is generally relatively uniform in thickness (ca. one micron) over the entire grain surface (except as noted above). The scabrate sculpture, consisting of evenly spaced elements less than 0.4 micra in diameter, is also present over the whole surface of the grain. It is most distinct in grains of *E. nudiflora* and *E. pterocarpa* and least so in *E. chrysolepis*.

Interspecific pollen morphological differences are evident in the genus, although a greater range of material must be studied before definite conclusions can be made. Tentatively it can be suggested that there are three basic pollen types within the genus. These can be designated arbitrarily as *E. chrysolepis* type, *E. nudiflora-Alfaroa* type, and *E. spicata* type.

Grains of the *Engelhardia chrysolepis* type are distinct. The grains are extremely small (12.8–17.4μ), distinctly triangular in polar view, oblate (index 0.57), endopore is elongated equatorially, exopore is elongated meridionally, ektexine does not thicken at the pore, no columellae are discernible, and the scabrate sculpture is extremely fine. On the basis of

the material studied, this type occurs only in *E. chrysolepis*. This is consistent with the findings of Stachurska (1961).

Pollen grains of the *E. nudiflora-Alfaroa* type are larger (16.8–23.8μ), rounded-triangular in polar view, suboblate (index 0.76), endopore is not elongated equatorially, exopore is more or less circular, ektexine thickens slightly within the vestibulum, columellae are visible within the vestibulum, and the sculptural pattern is more distinct. This type has been found in *E. nudiflora*, *E. pterocarpa*, and *E. serrata* var. *cambodica*. This pollen type is similar in most respects to *Alfaroa*.

The *Engelhardia spicata* type is similar to the *E. nudiflora-Alfaroa* type, but differs in that the grains are apt to be oblate-spheroidal (index 0.89) and possess the variable differentially thickened exine. This makes the grains angular in polar view (Stachurska refers to these as "hexagonal forms"). As mentioned previously, the angularity is due to a sharply undulating exine, possibly a function of uneven thickening. Along the ridges (thickened areas) columellae can sometimes be seen. In many grains of the *E. spicata* type the vestibulum is not clearly developed. The fact that not all of the grains of a sample possess the differential thickening and that the degree of expression is variable renders an interpretation difficult. The morphological and taxonomic significance of the feature can be assessed more properly through the study of thin sections.

In the present study grains of the *E. spicata* type were found strongly developed in collections of *E. spicata*, *E. spicata* var. *acerifolia*, and *E. apoensis*, and less frequently developed in collections of *E. parvifolia* and *E. spicata* var. *colebrookiana*. Stachurska has reported it in *E. parvifolia*, *E. spicata*, and *E. philippinensis* (= *E. spicata*) and to a lesser degree in *E. colebrookiana* (= *E. spicata* var. *colebrookiana*) and *E. acerifolia* (= *E. spicata* var. *acerifolia*).

Platycarya

The pollen grains of *Platycarya* are tectate, triporate (2–5 pores), oblate in shape, triangular in polar view, and possess a fine scabrate sculpture (TEXT-FIGURES 16–24). The grains are unique in possessing a pair of arcuate pseudocolpi on each polar hemisphere. The pores are equatorial in position, the endopore is elongated equatorially, and the exopore meridionally (TEXT-FIGURE 23).

The pseudocolpi are distinctive features. They are sharp, slit-like thinnings of the ektexine, involving either the inner portion of the tectum or deeper layers of the ektexine. The outer layer of the tectum, although sharply invaginated, is continuous over the pseudocolpi, since the scabrate sculpture is visible in these regions. The longer of the two pseudocolpi on each hemisphere describes an arc of about 12 micra, the shorter one of approximately six micra. The functional significance of the structures is not known, but their similarity to colpi led Faegri and Iversen (1950) to classify the grains as extraporate (possessing both pores and colpi but with the pores not included in the colpi).

The exine is essentially homogeneous and of uniform thickness. Colu-

mellae cannot be differentiated. The scabrate sculpture is present over the whole surface, including vestibulum and pseudocolpi, and consists of evenly spaced elements (micro-echinae?) less than 0.3 micra in diameter.

The grains of *Platycarya* vary in size from 13.1 to 17.2 micra (mean about 15.0μ) (See TABLE 3).

TABLE 3. **Pollen-Size in Platycarya strobilacea**

DATA FROM PRESENT STUDY *		DATA FROM STACHURSKA (1961)
X (μ)	RANGE (μ)	RANGE (μ)
14.5	13.1–15.6	18.7–22.0 **
15.5	13.1–17.2	22.0–27.0 ***
Ave: 15.0	13.1–17.2	24.0–27.0 †

* n = 50 for each collection
** triporate grains
*** tetraporate grains
† pentaporate grains

It is interesting to note that, aside from the presence of pseudocolpi, the grains of *Platycarya* are remarkably similar to those of the *Engelhardia chrysolepis* type; both are small, triangular, oblate, possess an elongated vestibulum and pore aperture, an essentially homogeneous exine, and a fine scabrate sculpture.

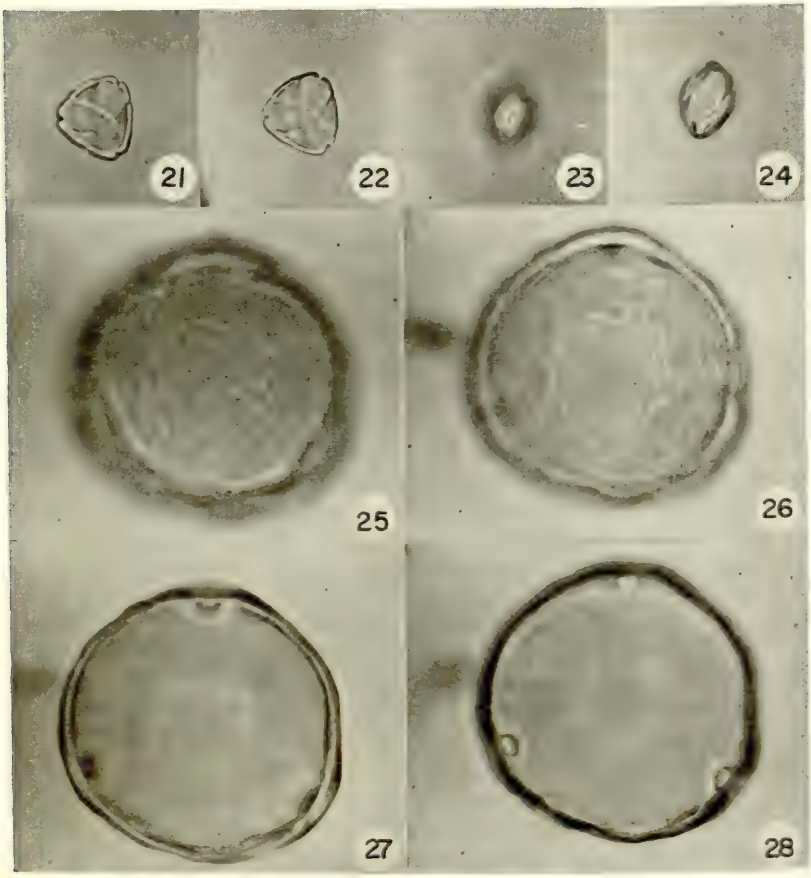
Carya

The pollen grains of *Carya* are tectate, triporate (1–6 pores have been observed), suboblate in shape, rounded-triangular to circular in polar view, and possess a fine scabrate sculpture (TEXT-FIGURES 25–49, 101–104). The grains are distinctly heteropolar; the pores are never exactly equatorial in position, but drawn somewhat towards one pole (the distal), leaving one hemisphere (proximal) pore-free. Correlated with the heteropolarity is a distinct thinning of the exine on the proximal pole (TEXT-FIGURES 25, 26, 33–36). The pore vestibulum is an open, low to greatly flattened cone. It is delimited by the endexine which stops approximately four to six micra short of the exopore, leaving a low, poorly defined rim (TEXT-FIGURES 31, 32, 37). The ektexine thickens quite distinctly within the vestibulum; the pore aperture is more or less circular in outline.

The pollen grains of *Carya* vary in size from 26.5μ (one grain of *Carya cordiformis*) to 63.2μ (one grain of *C. tomentosa*). Mean pollen size ranges from 33.3μ for *C. tonkinensis* (one collection) to 50.7μ for *C. tomentosa* (11 collections). TABLE 4 summarizes these data and those of Stone (1963), Andersen and Cain (personal communication), and Stachurska (1961). In general, grains seem to be largest in section CARYA and smallest in section APOCARYA. More important, however, is the correlation between ploidal level and grain size (Stone 1961, 1963; Whitehead, 1963). The tetraploids of section CARYA possess the largest grains.

The ektexine of *Carya* grains is distinctly stratified. This is especially evident within the vestibulum, where a distinct thick tectum is present, in addition to a well developed columella layer. The endexine, not present within the vestibulum, is relatively thin. Work with electron microscopy (Stone *et al.*, 1964) indicates that the layer identified as endexine with light and phase microscopy actually consists of the innermost layer of ektexine (foot layer) and endexine.

The ektexinous thickening near the pore involves two layers of which the columella layer is the primary contributor. In most species of *Carya* the columellae can only be seen within the area of the ektexinous thickening (which may coincide in extent with the vestibulum or stretch slightly beyond it). In general the columellae in this region are highly variable in



TEXT-FIGURES 21–28. Magnification 690 ×. Each series (e.g., 25–28) represents successively lower levels of focus. 21–24, *Platycarya strobilacea*, polar view (21, 22, continuation of series beginning at 16); equatorial view (23, 24). 25–28, *Carya tomentosa*, polar view.

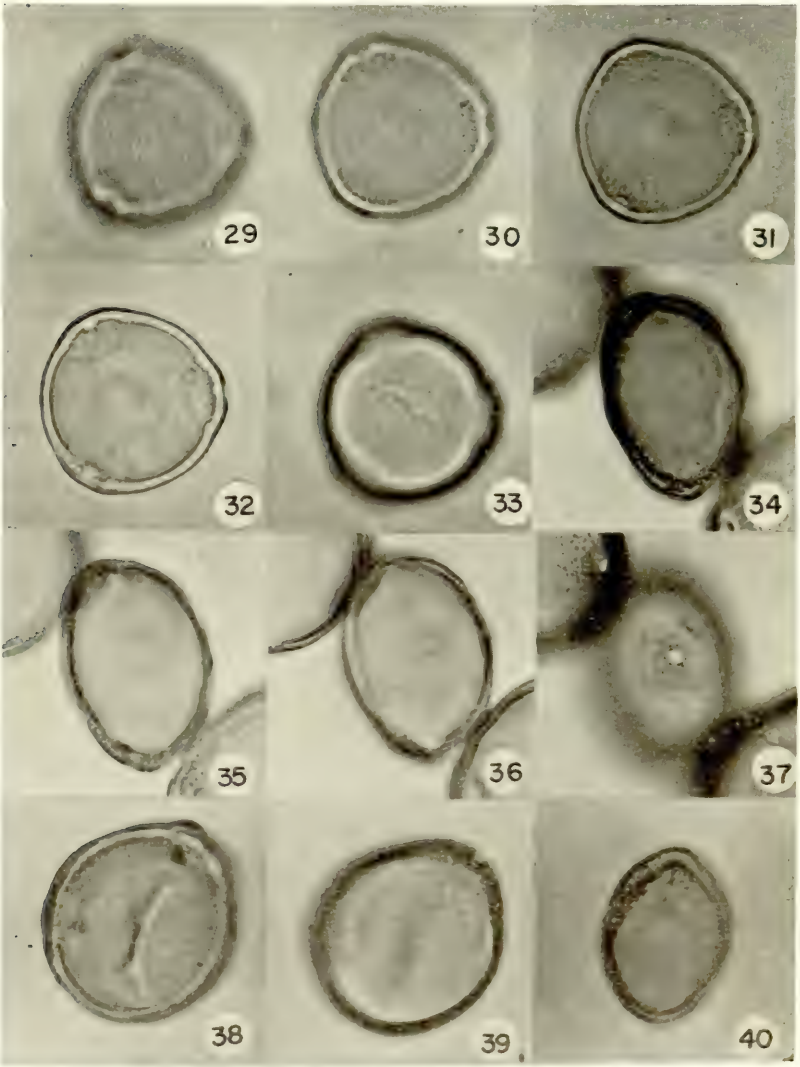
TABLE 4. **Carya Pollen-Size Data**

		WHITEHEAD			STONE			ANDERSEN & CAIN			STACHURSKA	
		$\bar{X}$	RANGE OF VARIATION	NO. COLL.	$\bar{X}$	RANGE OF VARIATION	NO. COLL.	$\bar{X}$	RANGE OF VARIATION	NO. COLL.	RANGE OF VARIATION	"MOST FREQUENT DIAMETER"
§ CARYA												
carolinae-septentrionalis	(2*n*)	—	—	—	43.7	42–45	3	—	—	—	—	—
floridana	(4*n*)	—	—	—	44.1	41–47	7	—	—	—	—	—
glabra	(4*n*)	46.88	40.80–53.04	2	51.7	48–57	11	50.37	43–47	5	38.5–59.5	49.0–52.5
laciniosa	(2*n*)	45.00	38.76–51.00	2	47.5	46–50	6	46.82	41–53	5	45.5–48.2	52.5–54.2
leiodermis		47.49	40.80–53.04	1	49.7	46–54	7	—	—	—	—	—
ovalis	(4*n*)	47.65	36.72–53.04	2	50.4	48–53	11	52.81	46–59	4	56.0–96.5	65.5
ovata	(2*n*)	44.93	36.72–51.00	3	46.5	43–52	13	48.30	42–54	5	42.0–61.2	49.0–52.5
pallida		49.82	42.84–55.08	1	49.3	45–54	7	—	—	—	53.0–75.0	62.0
texana	(4*n*)	46.27	40.80–53.04	2	48.2	42–52	16	—	—	—	—	—
tomentosa	(4*n*)	50.65	40.80–63.24	11	51.9	49–57	22	52.53	47–60	5	45.5–59.5	52.5
glabra (Florida)		—	—	—	47.7	44–50	15	—	—	—	—	—
§ APOCARYA												
aquatica	(2*n*)	41.80	36.72–46.92	2	41.7	40–46	4	—	—	—	36.4–54.2	43.7
cathayensis		—	—	—	—	—	—	—	—	—	—	—
cordiformis	(2*n*)	40.36	26.52–46.92	11	42.0	40–44	11	42.61	39–48	5	40.2–50.7	45.5–47.2
illinoensis	(2*n*)	46.10	38.76–55.08	2	48.0	43–53	9	—	—	—	38.5–56.0	49.0
myristiciformis	(2*n*)	39.64	32.64–44.88	2	42.1	39–47	15	—	—	—	38.5–52.5	43.7–52.5
tonkinensis		33.25	28.56–38.76	1	32.6	32–33	3	—	—	—	—	—
poilanei		—	—	—	38.5	—	1	—	—	—	—	—
palmeri		—	—	—	44.4	42–46	14	—	—	—	—	—
× *lecontei*		—	—	—	47.9	47–49	2	—	—	—	—	—
§ RHAMPHOCARYA												
sinensis		38.23	30.60–44.88	1	35.7	—	1	—	—	—	—	—

size and are irregularly distributed (TEXT-FIGURES 101–104). Clumping of columellae is not infrequent. In only a few species can columellae be differentiated in the polar region (and never on the proximal pole), and there they are invariably smaller and more tightly packed. There is usually a rather uniform gradation from pole to pore, with columellae becoming progressively larger and more widely spaced. In some species (e.g., *C. tonkinensis*, TEXT-FIGURE 102) there is a sharp line of demarcation between polar region and vestibulum. In those species in which the columellae are most distinct, there is also a gradient between pole and interporium (equatorial region between the pores). The columellae are visible in the interporium, but smaller and more tightly packed than in the vestibulum. As can be seen in the electron micrographs of Stone *et al.* (1964), a columella layer is actually present in all portions of the grain; columellae, appearing as "variable-sized, anastomosing rods," can be differentiated throughout. The distribution detected with light and phase microscopy is therefore partly an artifact caused by limitations of technique. Too few data are available as yet to indicate whether columella distribution can be used to characterize species, although some possibilities appear to be present. These are noted at the end of this section and in the discussion.

The thin polar area poses some problems of interpretation. If one follows Stachurska (1961) and Wodehouse (1935), it is not a question of a thinning of the exine, but of the exinous thickenings which surround the pores coalescing and leaving only the pole free. However, by careful observation with light and phase microscopy (oil immersion) it is possible to determine the extent of the ektexinous thickening; i.e., the region within which the columellae can be differentiated most readily and within which they have the most irregular distribution. In those species which possess the most extensive ektexinous thickening (continuing beyond the vestibulum and encroaching upon distal pole and interporium, e.g., *Carya cordiformis*, TEXT-FIGURE 103), the interpretation of Stachurska and Wodehouse would seem to fit. However, even in such types it can be seen that the polar thinning is considerably more restricted in area than the region covered by the ektexinous thickening. Furthermore, in *Carya tonkinensis* (TEXT-FIGURE 102) the thickenings are confined to the vestibulum (which itself is highly restricted), yet a distinct polar thinning is visible (TEXT-FIGURE 33). It would thus seem that the polar thinning is a feature unrelated to the exinous thickenings surrounding the pores. The thinning probably involves largely the columella layer as columellae are never visible in this region, and since the scabrate sculpture is continuous over the thinning. This interpretation has been corroborated by electron microscopy (Stone *et al.*, 1964).

As suggested above, it is extremely difficult to attach any taxonomic significance to the morphological features observed. There is great variation from collection to collection and occasionally within a collection as well. This is true with respect to the frequency of tetraporate grains, columella distribution, character of the ektexinous thickening, degree of



TEXT-FIGURES 29–40. Magnification 690 ×. Each series (e.g., 29–33) represents successively lower levels of focus. 29–33. *Carya tonkinensis*, polar view. 34–40, *Carya aquatica*, 34–37, equatorial view to show polar thinning; 38, 39, diporate grain; 40, monoporate grain.

heteropolarity, etc. Stachurska's pollen groups seem to be more a reflection of the particular grains studied than characteristic of the species in question. This is certainly true with respect to pore frequency, extent of the exinous thickening, and position of the pores. The author found no grains with truly equatorial pores in any of the collections studied, al-

though less heteropolar grains were found in a few species (e.g., *C. tonkinensis*, *C. sinensis*, *C. illinoensis*, etc.).

The observations on fine structure made in the course of the investigation are summarized in the following paragraphs.

Section CARYA. (1) *Carya glabra* (2 collections): columellae within vestibulum large and distinct, irregular in size and distribution. Columellae visible on distal pole are small and tightly packed. Uniform gradation from pole to both pore and interporium. Columellae visible in interporium, but very tightly packed. (2) *C. laciniosa* (2 collections): arrangement of columellae as for *C. glabra*. (3) *C. leiodermis* (1 collection): morphology as for two preceding species, but structure finer, columellae not discernible on pole and interporium. (4) *C. ovalis* (2 collections): structure intermediate between *C. glabra* and *C. leiodermis*. Some columellae visible on distal pole, but very fine and tightly packed. (5) *C. ovata* (3 collections): much variation from collection to collection; one similar to preceding species, with very fine columellae visible on interporium; another with extremely coarse and widely spaced columellae within vestibulum and distinct large columellae on the distal pole; a third with an extraordinarily thick tectum and columella layer within the vestibulum. (6) *C. pallida* (1 collection): ektexine within the vestibulum unusually thick (reported also by Stachurska), exine varies in thickness over the surface of the grain giving a rather undulating appearance. Columella distribution as in grains of *C. glabra*. (7) *C. texana* var. *arkansana* (2 collections): grains more regular than in the preceding species, outline regularly rounded-triangular. Vestibulum sharply defined. Abrupt transition from vestibulum to polar area. Very large and irregularly distributed columellae within vestibulum; columellae not visible on rest of grain surface. (8) *C. tomentosa* (11 collections): In general, columellae visible on both interporium and distal pole, with a gradation from both pole and interporium to vestibulum (and from pole to interporium) (TEXT-FIGURE 104). Packing of columellae is variable.

Section APOCARYA. (1) *C. aquatica* (2 collections): collections variable, one with uniform gradation from pole to pore zone and with columellae relatively tightly packed within pore zone and not visible on the pole; the other with a sharp line of demarcation between polar zone and pore zone, and columellae within pore zone very large and widely spaced. (2) *C. cordiformis* (11 collections): Much variability is evident. In general, the ektexinous thickenings are extensive and encroach upon both interporium and distal pole (TEXT-FIGURE 103). The columellae within the ektexinous thickenings are usually large and irregularly spaced. Some collections have an unusually wide spacing of columellae, giving the vestibulum an essentially "empty" look (TEXT-FIGURE 103). In some collections there is a gradation from pole to pore, in others an abrupt change (the latter condition seems to prevail in two collections of *C. cordiformis* var. *latifolia*). (3) *C. illinoensis* (2 collections): the pollen grains appear to be more triangular than in many of the preceding species, apparently due to a distinct, localized thickening of the ektexine at the pore. The grains

also tend to be a little less heteropolar. Both the vestibulum and ektexinous thickening are restricted in area and there is a sharp contrast in columella pattern between this region and the polar hemispheres. Within the pore zone the columellae are highly irregular in size and shape. The relatively small area covered by the ektexinous thickening corresponds to the reports of Wodehouse (1935) and Stachurska (1961). (4) *C. myristiciformis* (2 collections): columella distribution gradational from pole to pore, columellae not visible on pole. A few "islands" of tightly packed fine columellae are evident on the distal pole of a few grains from one collection. The columellae within the vestibulum are more uniformly distributed and more tightly packed than in most species. (5) *C. tonkinensis* (1 collection): pollen grains are very small; pores more equatorial than in other species; endexine break at border of vestibulum more distinct than in most; vestibulum and ektexinous thickening very restricted. Columellae visible only within the vestibular area. Columellae large, irregular, and widely spaced (TEXT-FIGURE 102). Sharp lines of demarcation between vestibulum and polar zone (partly due to break in endexine, partly to the change in columella distribution). There is an apparent concentration of columellae at the base of the vestibulum (near the endexine break) and also around the aperture.

Section RHAMPHOCARYA. (1) *Carya sinensis* (1 collection): grains relatively small (see also Stone, 1963), somewhat more triangular in polar view than other species, and a little less heteropolar. Vestibulum restricted as in *C. tonkinensis*, and defined by a rather sharp break of the endexine. Ektexinous thickening restricted in area, sharp line of demarcation between pore area (within which are large, irregular, widely spaced columellae) and polar hemispheres (TEXT-FIGURE 101). Thinning of proximal pole as in all other species.

On the basis of size, restricted ektexinous thickening, slightly protuberant pores, and relative isopolarity, grains of *Carya tonkinensis* and *C. sinensis* approach those of the *Engelhardia nudiflora-Alfaroa* type. This might indicate that grains of these species are primitive for the genus. Should this assumption be valid, then one may suggest that the evolutionary trends within the genus (with respect to pollen morphology) would be towards increased pollen size, increased heteropolarity, more extensive ektexinous thickenings and the development of larger and more distinctive columellae. Pollen size and heteropolarity are to a degree related, and the ektexinous thickenings and columella patterns are certainly related. However, the former two and latter two could be thought of as relatively independent evolutionary trends.

The grains of *Carya sinensis* are worthy of further comment, especially considering the varied opinions held concerning the taxonomic position of the species (e.g., Manning and Hjelmqvist, 1951; Scott, 1953; and Leroy, 1952, 1953). On the basis of pollen morphology alone, the taxon would appear to be closely allied to *Carya*. The grains are clearly *Carya*-like; in fact, indistinguishable from those of many of the species. This would certainly support the conclusions of Manning and Hjelmqvist (loc. cit.) who

have placed it in section RHAMPHOCARYA of the genus *Carya*. As was suggested to the writer by Stone (personal communication) the greater degree of triangularity of *Carya sinensis* grains (compared to *C. tonkinensis*), a condition noted in grains of the *Alfaroa-Engelhardia nudiflora* type, indicates that the *sinensis* type might be more primitive than the *tonkinensis* type.

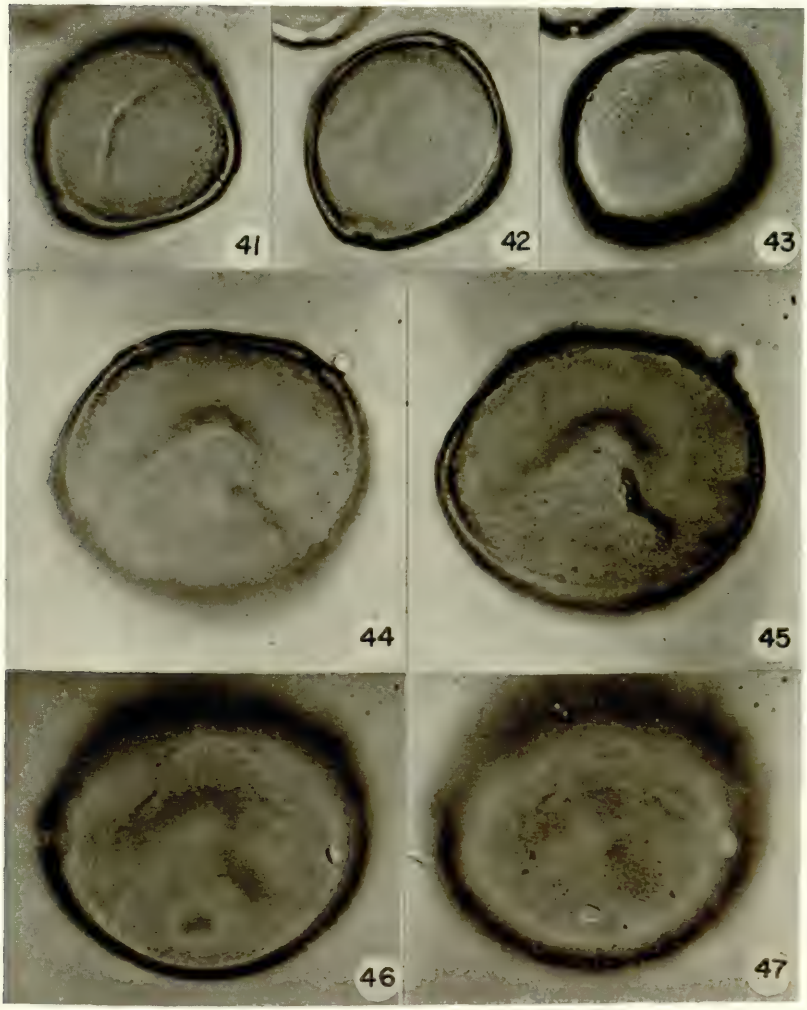
Pterocarya

The pollen grains of *Pterocarya* are prevailingly stephanoporate, possess from three to nine pores (the mean figure is roughly 5.8 for the genus), are polygonal to circular in polar view, oblate to suboblate in shape, and have a distinct scabrate sculpture (TEXT-FIGURES 80–100, 106). The pores are distinctly aspidate, the ektexine generally thickens perceptibly within the vestibulum, and the pore aperture varies in shape from circular (TEXT-FIGURE 92) to elongate (TEXT-FIGURE 91). Elongate apertures tend to be more frequent than circular ones. The grains, although characteristically stephanoporate, are occasionally periporate and heteropolar as in *Juglans* (TEXT-FIGURES 92–94). This condition is most prevalent in grains with seven or more pores. The heteropolar grains generally possess only one or two pores on the distal surface, the remaining pores being strictly equatorial in position. The frequency of heteropolar grains varies from collection to collection. It is lowest in one collection of *Pterocarya paliurus* (0%) and highest in a collection of *Pt. rhoifolia* (34%) (see TABLE 5). Some tendency towards heteropolarity can be found in many other stephanoporate grains in that one or two pores may be positioned slightly off of the equator, and the grains are often slightly plano-convex in equatorial view. No evidence of any ektexinous thinning on the proximal side has been found.

Grains of *Pterocarya* vary in size from 25.9μ (one grain of *Pt. paliurus*) to 38.8μ (several species). Mean pollen size varies from 28.6μ (*Pt. hupehensis*, 1 collection) to 35.5μ (*Pt. insignis*, 1 collection). Pore number varies from 3 to 9. Species' means range from 4.1 (*Pt. paliurus*) to 6.5 (*Pt. rhoifolia*). (For the purpose of these discussions, Stachurska's observations on *Pt. rhoifolia* have been omitted. The collection that she studied had unusually high pore number for the genus (7.6), an unusually high percentage of heteropolar grains (75%), and the modal class for pollen size was larger than for other species of *Pterocarya*. It is likely that this herbarium sheet was identified incorrectly and represents instead a species of *Juglans* (possibly *J. cathayensis*).)

The individual collection data for mean pore number and mean pollen size are plotted on a scatter diagram (FIGURE 108).

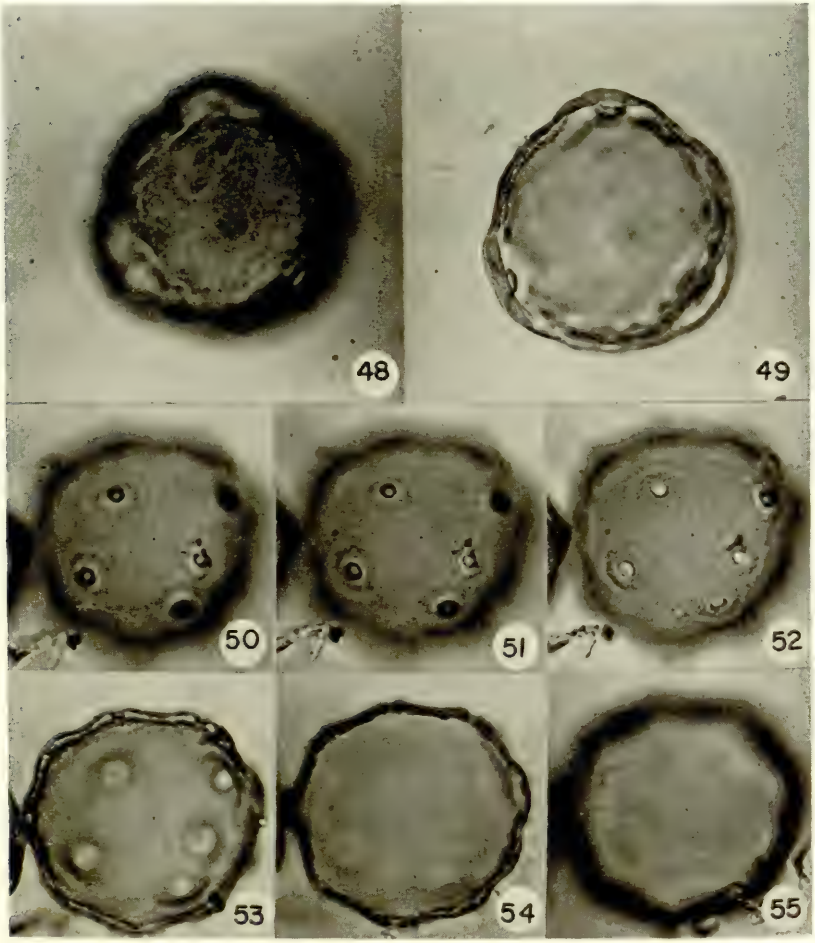
The exine of *Pterocarya* grains is relatively homogeneous. Columellae can never be distinguished outside of the vestibular region and are often difficult to discern even within that zone. The ektexine thickens very slightly at the pore. Both tectum and columella layer are involved in this thickening. The vestibulum of the pore is a relatively distinct feature,



TEXT-FIGURES 41–47. Magnification 690 ×. Each series (e.g., 41–43) represents successively lower levels of focus. 41–43, *Carya aquatica*, polar view, tetraporate grain. 44–47, *Carya glabra*, polar view, hexaporate grain.

partly because the endexine breaks off sharply at the base of the vestibulum and partly because there is a concentration of columellae at that point and around the aperture. The remainder of the ektexine within the vestibulum is often free of columellae.

With the exception of low pore number in *Pterocarya paliurus* (section CYCLOPTERA) there appear to be no morphological criteria which have any intrageneric taxonomic significance.



TEXT-FIGURES 48–55. Magnification 690 ×. Each series (e.g., 50–55) represents successively lower levels of focus. 48, 49, *Carya pallida*, polar view. 50–55, *Juglans regia*, polar view.

Juglans

The pollen grains of *Juglans* are relatively variable. They (TEXT-FIGURES 50–79, 107) are tectate and basically periporate and heteropolar. The pores are restricted to one polar hemisphere or may encroach slightly upon the other. Pore number varies from two to 37 for the genus, although individuals with from 6 to 18 pores are most frequent. The mean pore-number varies from a minimum of 7.3 for *J. cathayensis* (2 collections) to a maximum of 17.4 for *J. nigra* (42 collections; Whitehead, 1963). The pores are apt to be strictly equatorial in grains with low pore number, hence such grains can be classified as stephanoporate (TEXT-

TABLE 5. **Pollen-Size and Pore-Number in Pterocarya**

	PRESENT STUDY [1]					STACHURSKA					WODEHOUSE	
	$\bar{x}$ (μ)	RANGE (μ)	$\bar{x}$ (PORE NO.)	RANGE (PORE NO.)	% STEPH.	RANGE (μ)	MODAL CLASS	$\bar{x}$ (PORE NO.)	RANGE (PORE NO.)	% STEPH.	SIZE (μ)	PORE NO.
§ CYCLOPTERA												
paliurus	30.1	25.9–33.1	4.1	3–5	100	24.5–40.3	30.0	4.1	3–5	100	33.1	5–7 [3]
§ DIPTERA												
fraxinifolia [4]	34.3	30.0–38.8	5.8	4–8	94.6	30.6–43.2	38.0	6.2	3–8	98	33–35	4–6
hupehensis	28.6	24.5–34.7	5.4	4–8	99.5	28.0–36.7	31.5	5.3	4–7	98	29–31	4–6
stenoptera [4]	31.9	28.0–36.7	6.5	5–9	91.0	30.6–39.0	36.0	6.4	5–8	91	26–30	3–6
§ PLATYPTERA												
delavayi	32.2	28.6–38.8	5.8	4–7	85.6	— —	—	—	—	—	—	—
forrestii	—	— —	—	—	—	35.6–46.3	39.2	5.3	4–7	99		
insignis	35.5	32.6–38.8	5.3	4–7	98.8	33.8–43.5	38.6	6.3	5–8	100		
rhoifolia	33.4	30.6–36.7	6.5	5–8	80.8	37.8–46.8 [2]	45.0 [2]	7.6 [2]	6–10 [2]	25 [2]		

[1] n = 50 for all collections
[2] = values all unusual for *Pterocarya*, specimen probably a *Juglans*.
[3] = some heteropolar grains noted
[4] = two collections studied

TABLE 6. **Pollen-Size and Pore-Number in Juglans**

SPECIES	MEAN SIZE (μ)	SIZE RANGE (μ)	MEAN PORE NO.	PORE NO. RANGE	PERCENT STEPHANOPORATE
§ RHYSOCARYON					
J. australis *	32.3	28.6–36.7	10.9	7–17	<1%
J. boliviana	30.3	25.9–34.6	10.0	8–12	
J. californica *	36.3	30.6–40.8	12.5	8–19	
J. hirsuta *	36.4	30.6–44.9	13.4	9–18	
J. insularis	32.1	28.6–34.7	9.9	8–14	
J. jamaicensis	32.0	28.8–36.0	9.7	6–12	<1%
J. major **	34.7	24.5–40.8	11.5	4–17	
J. microcarpa *	34.8	30.6–40.8	13.8	9–22	
J. neotropica *	32.9	28.6–37.4	11.3	7–16	
J. nigra ***	34.7	28.6–40.8	17.4	9–37	
J. olanchana	32.4	28.6–34.6	11.4	8–14	
§ DIOSCARYON					
J. regia †	42.6	34.7–50.0	13.6	9–20	
§ CARDIOCARYON					
J. sieboldiana	37.4	32.6–42.8	8.3	6–11	3.3%
J. cathayensis *	33.8	30.6–40.8	7.3	5–10	ca. 1%
J. cinerea ††	35.6	28.6–40.8	7.8	2–15	10–35%
J. mandshurica	38.6	34.7–42.8	8.3	6–11	2.3%

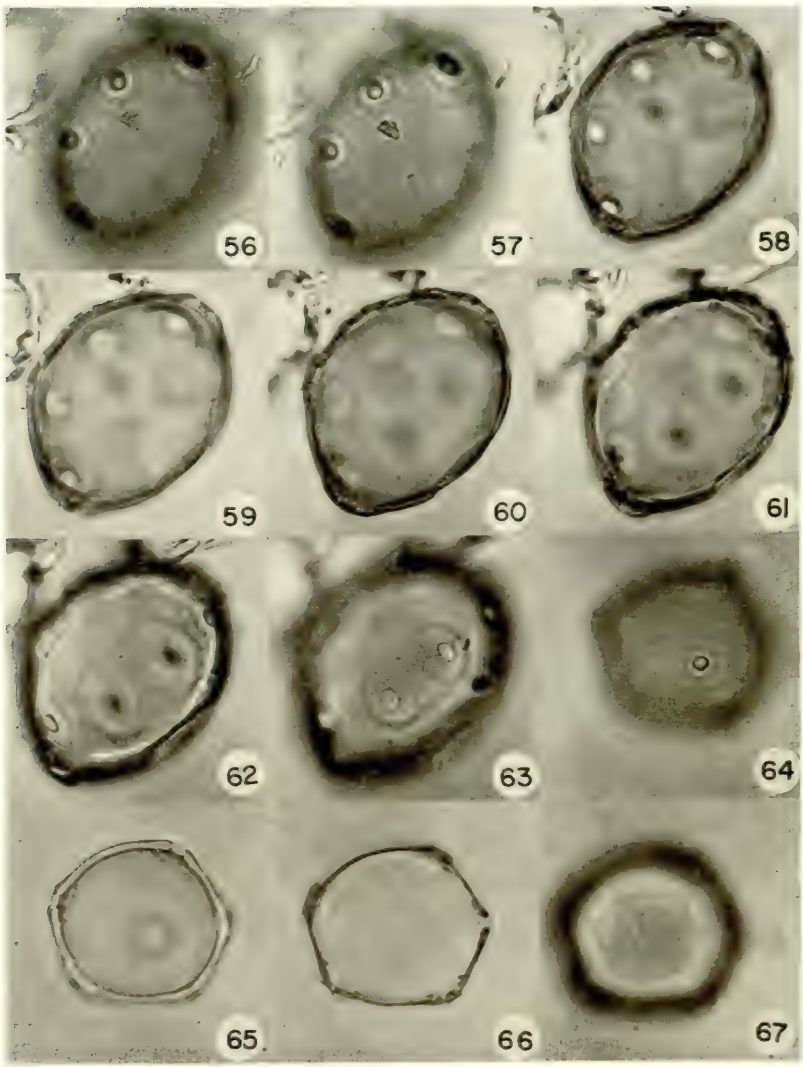
* 2 collections
** 4 collections
*** size based on 3 collections, pore number on 42 coll. (Whitehead, 1963)
† 3 collections
†† size based on 2 collections, pore no. on 44 coll. (Whitehead, 1963)

FIGURES 68–70). The frequency of stephanoporate grains is variable and is highest in one collection of *Juglans cinerea* (35%) (See TABLE 6 for further data). The grains are either circular or polygonal in polar view. Grain shape varies from suboblate to oblate-spheroidal. A distinct thinning of the ektexine occurs on the pore-free (proximal) pole (TEXT-FIGURES 58–62). The sculpture is distinctly scabrate.

The pores are generally aspidate, but the degree is highly variable (TEXT-FIGURES 69, 77). The vestibulum varies accordingly from a low, flattened cone to a fairly steep-sided one. The ektexine usually thickens slightly within the area of the vestibulum. In occasional grains the thickening is extremely pronounced (TEXT-FIGURE 71). The pore aperture ranges from circular to elongate in shape.

The pollen grains of *Juglans* vary in size from a minimum of 24.5μ (one grain of *Juglans major*) to a maximum of 50.0μ (one grain of *J. regia*). The species' means range from 30.3μ for *J. boliviana* (1 collection) to 42.6μ for *J. regia* (3 collections).

Individual collection data for pore number and pollen size are plotted in the scatter diagram (FIGURE 108).



TEXT-FIGURES 56–67. Magnification 690 ×. Each series (e.g., 56–63) represents successively lower levels of focus. 56–63. *Juglans regia*, equatorial view (note especially sculptural pattern and the polar thinning in 59–62). 64–67, *Juglans cathayensis*, polar view of hexaporate grain with one global pore.

The exine is of relatively uniform thickness over the entire grain surface except on the pore-free pole and within the vestibulum. The polar thinning appears to be similar to that observed in grains of *Carya*, and probably involves reduction of the columella layer. This has been corroborated by electron microscopy (Stone *et al.*, 1964). As the scabrate sculpture is

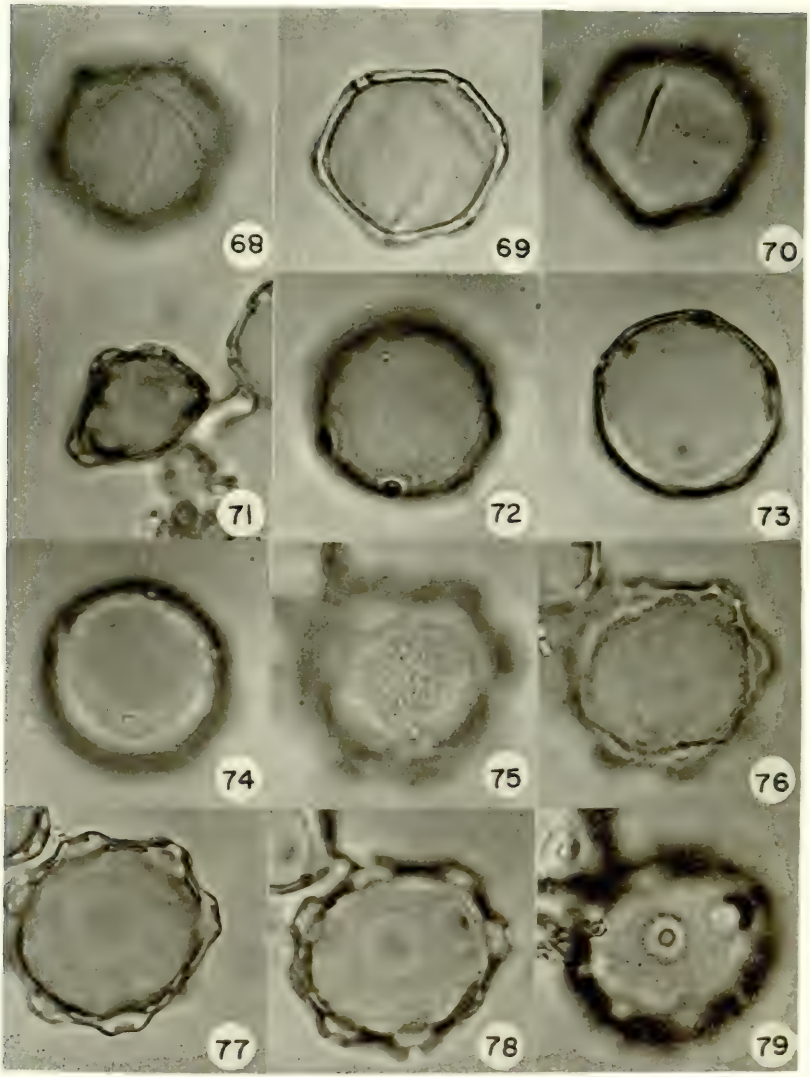
continuous over the thinning, at least some tectum must be present. The thinning is not detectable in stephanoporate grains. The exine appears to be relatively homogeneous. Columellae cannot be differentiated outside of the vestibular region and are often difficult to observe even within it. Once again, this observation appears to be based on an artifact of technique, since application of electron microscopy has shown that the columella layer occurs in all portions of the grain (Stone *et al.*, loc. cit.). The most usual situation is to find columellae concentrated at the base of the vestibulum (TEXT-FIGURE 107) and around the pore aperture. There is usually a columella-free zone of variable width between these two regions of concentration, although narrow "flames" of columellae may extend into it.

The sculptural pattern is continuous over the entire surface, including both vestibulum and proximal pole. It varies in distinctness from collection to collection, but is generally visible only under oil immersion. It appears to be most distinct in collections of *J. regia*, which also possess the largest grains.

Pollen size and pore number appear to have some taxonomic significance within the genus *Juglans*. This is clearly indicated on the scatter diagram (FIGURE 108). The species of section CARDIOCARYON are characterized by low pore number (means from 7.2 to 8.6 for individual collections), a higher frequency of stephanoporate grains (obviously correlated with pore number), and pollen grains ranging in size from approximately 33 to 39 micra. Pollen size is approximately the same for section RHYSOCARYON, but mean pore number is distinctly higher. It ranges from a minimum of 9.7 in *J. jamaicensis* to 17.4 in *J. nigra*. Pollen grains of *Juglans regia* (section DIOSCARYON) have approximately the same pore number as those of section RHYSOCARYON, but are distinctly larger. It would appear that grains of the *Cardiocaryon* type, which are similar to those of the less advanced genus *Pterocarya*, are primitive for the genus, and that the primary evolutionary trends have been towards an increase in pore number (culminating in *J. nigra*) and an increase in pollen size (leading to *J. regia*).

The markedly higher pore number characteristic of grains of *Juglans nigra* suggests that that species has occupied a position isolated (geographically and/or genetically) from other species of section RHYSOCARYON for some time. Similarly, the relatively small grain size and low pore number of the tropical American species of section RHYSOCARYON (*J. olanchana*, *J. australis*, *J. insularis*, *J. neotropica*, *J. boliviana*) suggests their early separation from other species of the section and retention of more "conservative" pollen morphological features.

The plotted points for the two collections of *J. microcarpa* pose a problem. One (*Palmer 11327*, from Texas) falls within the *J. nigra* region of the scatter diagram, while the other (*Greene*, 1880, from New Mexico) plots near the two New Mexico collections of *J. major*. It would be instructive to review the taxonomic status of the collections in question. For example, Manning (personal communication) has suggested that *J.*



TEXT-FIGURES 68–79. Magnification 690 ×. Each series (e.g., 68–70) represents successively lower levels of focus. 68–70. *Juglans cathayensis*, polar view of hexaporate grain with equatorial pores only. 71. *Juglans olanchana*, aberrant grain, note extraordinarily thick ektexine within the vestibulum. 72–74. *Juglans mandshurica*, polar view (note non-aspidate pores). 75–79. *Juglans major*, polar view of grain with abruptly aspidate pores.

microcarpa would not be expected to occur in the portion of New Mexico from which the collection derived; the specimen may represent *J. major* instead.

No other features appear to have taxonomic significance. The writer

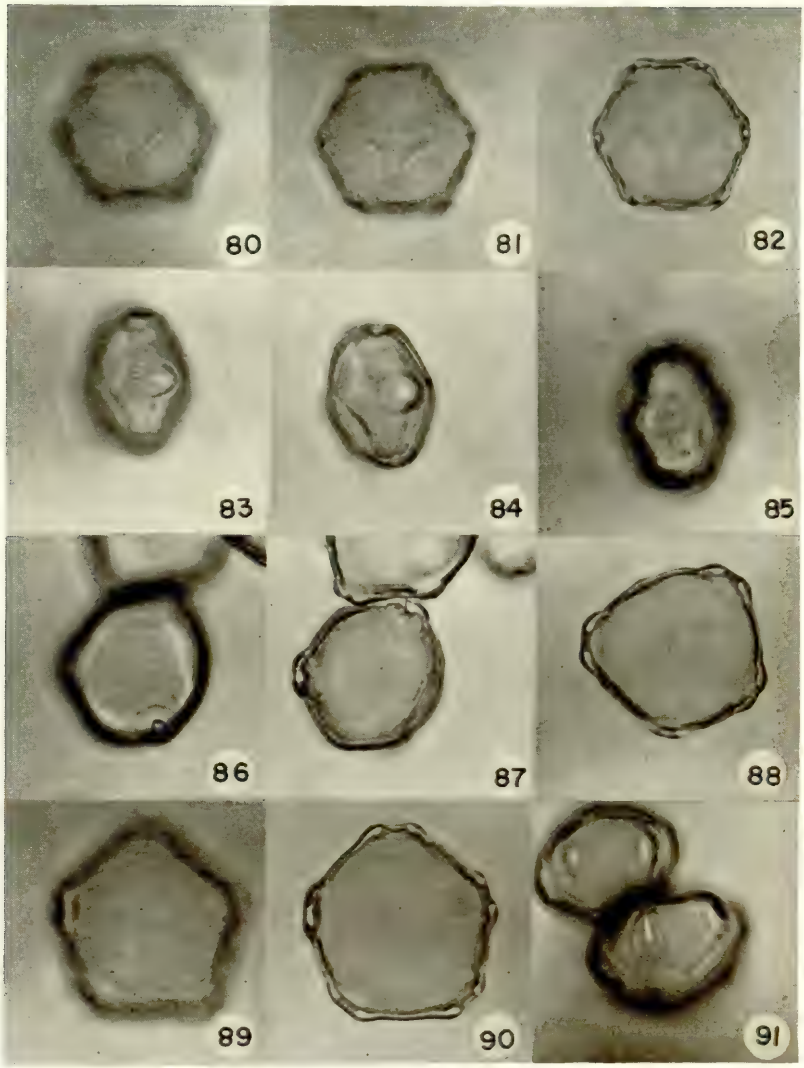
has not utilized the pollen groups established by Stachurska (1961) as, in general, they are based on characteristics (roundness of grains, protuberance of pores) that are apt to be profoundly altered by the state of preservation of the preparation; specifically the state of expansion of the grains. In fact, a number of Stachurska's photomicrographs (e.g., *Plate II*) are of grains which have been distended greatly by the swelling that one often encounters in glycerine-jelly preparations.

Following is a summary of observations on all *Juglans* collections studied.

Section RHYSOCARYON Dode. (1) *Juglans australis*: A few stephanoporate grains noted. This is highly unusual for the section. Distribution of columellae within vestibulum variable. (2) *J. boliviana*: distribution of columellae within vestibulum essentially "concentric," i.e., columellae concentrated around exopore and endopore, few between. (3) *J. californica*: "concentric" arrangement of columellae within vestibular area; a band of clumped columellae surrounding the pore aperture and another band at the base of the vestibulum. (4) *J. hirsuta*: columellae tightly packed within vestibulum, only a narrow, relatively columella-free zone between aperture and base of vestibulum. (5) *J. insularis* (*J. jamaicensis*): pore zone (vestibulum) relatively sharply defined; large and irregular patches of columellae at base of vestibulum and around the pore aperture; columellae widely spaced in between. (6) *J. major*: great variation from collection to collection. Both of the New Mexico collections have many grains with grossly protuberant pores and an extremely irregular scabrate sculpture. The other collections are more typical for the genus. Variation in fine structure is comparable; in some grains the pore zone is sharply defined by a definite concentration of columellae at the base of the vestibulum (FIGURE 107), in other grains there is a gradual transition from the homogeneous extra-vestibular exine to pore region. (7) *J. microcarpa*: considerable variation (see also previous discussion). Vestibulum structure as described for *J. californica,* with narrow columella-free zone between aperture and base. (8) *J. neotropica*: grains more rounded than in most collections, pores barely aspidate. Pore zone (vestibulum) relatively sharply defined; many large, irregularly distributed columellae within the zone. (9) *J. nigra*: vestibulum quite sharply defined; broad relatively columella-free zone extending from aperture nearly to base of vestibulum. Zone of columellae around pore aperture very narrow. Irregular "flames" of columellae extend from base of vestibulum into the columella-free area. (10) *J. olanchana*: many grains with unusually thick ektexine at the pore, great variability. Somewhat irregular distribution of columellae within the vestibular zone.

Section DIOSCARYON Dode. (1) *J. regia*: pore apertures appear to be unusually large. Sculpture often very distinct. A broad zone with large, irregularly spaced columellae around aperture; a rather diffuse zone of widely spaced columellae between this and the base of the vestibulum. Concentration of columellae also in basal zone.

Section CARDIOCARYON Dode. (1) *J. sieboldiana*: sharply defined pore



TEXT-FIGURES 80–91. Magnification 690 ×. Each series (e.g., 80–82) represents successively lower levels of focus. 80–82. *Pterocarya stenoptera*, polar view of hexaporate, stephanoporate grain. 83–85. *Pterocarya hupehensis*, equatorial view of hexaporate grain. 86, 87. *Pterocarya delavayi*, polar view of triporate grain. 88. *Pterocarya fraxinifolia*, polar view, tetraporate grain. 89, 90. *Pterocarya fraxinifolia*, polar view, pentaporate grain. 91. *Pterocarya stenoptera*, equatorial view, note elongate pore aperture.

zone; dense, narrow zone of columella at base; broad, columella-free zone extending from basal zone to relatively broad band of irregularly spaced columellae surrounding the aperture. Some irregular narrow rows of

columellae extending from base into columella-free zone. (2) *J. cathayensis*: sculpture very fine; fine structure variable; some grains with sharply defined pore zone, others not so. Some with broad columella-free zone within vestibulum, others with columellae relatively closely packed throughout vestibulum. (3) *J. cinerea*: pore zone not clearly differentiated; columellae relatively closely spaced. (4) *J. mandshurica*: grains quite rounded, pores barely aspidate. Pore zone not well differentiated. Broad zone of packed columellae around the aperture; occasionally a narrow columella-free zone between this and the region of densely packed columellae at the base of the vestibulum. Gradation from basal zone to dense ektexine of the grain surface.

DISCUSSION

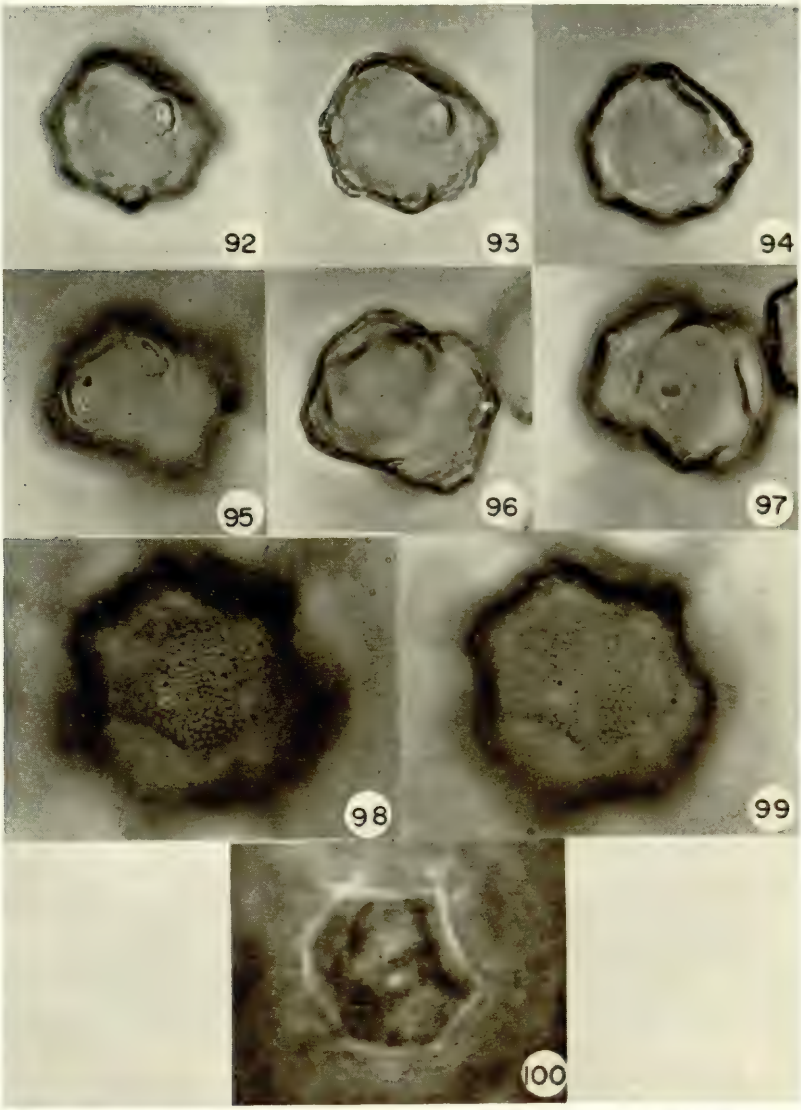
Generic distinctions. There are four different pollen types within the Juglandaceae: the triporate-isopolar *Engelhardia-Alfaroa* type; the triporate-pseudocolpate *Platycarya* type; the triporate-heteropolar *Carya* type; and the stephanoporate to periporate-heteropolar *Juglans-Pterocarya* type.

Pollen grains of the *Engelhardia-Alfaroa* type can be distinguished as follows: the pollen grains of *Platycarya*, although basically similar, always possess characteristic pseudocolpi. Grains of *Carya* are considerably larger (largest *Engelhardia-Alfaroa* grains: 26.2μ; smallest *Carya* grains: 26.5μ) are always heteropolar and possess an ektexinous thinning on the proximal pole. Also, grains of *Carya* tend to be more circular in polar view and have much more distinctive columellae within the vestibular area. Pollen grains of the *Juglans-Pterocarya* type are larger, have a higher pore number, and tend to have more aspidate pores. Triporate-isopolar *Pterocarya* and *Juglans* grains do occur, but they tend to be larger and have more aspidate pores.

The pollen grains of *Platycarya strobilacea* can be distinguished easily from those of all other taxa in the family by virtue of the distinctive pseudocolpi. These are invariably present, even on tetra- and pentaporate grains.

The combination of three pores, heteropolarity, polar thinning, distinctive columellae and relatively large grain size serves to distinguish *Carya* grains from all other types. As mentioned above, the grains are invariably larger than those of the *Engelhardia-Alfaroa* type, are always heteropolar and possess the distinctive ektexinous thinning. The triporate *Juglans-Pterocarya* grains have equatorial, more aspidate pores, lack the localized polar thinning, and have a somewhat thinner exine. Furthermore, the columellae within the vestibular zone are not as large, distinct, or as irregularly distributed as in *Carya* grains. The diporate and tetra- to hexaporate grains of *Carya* are also easily recognizable.

Within the *Alfaroa-Engelhardia* group it would appear that a reliable generic distinction cannot be made on the basis of pollen morphology. However, it must be admitted that significantly more material of the two

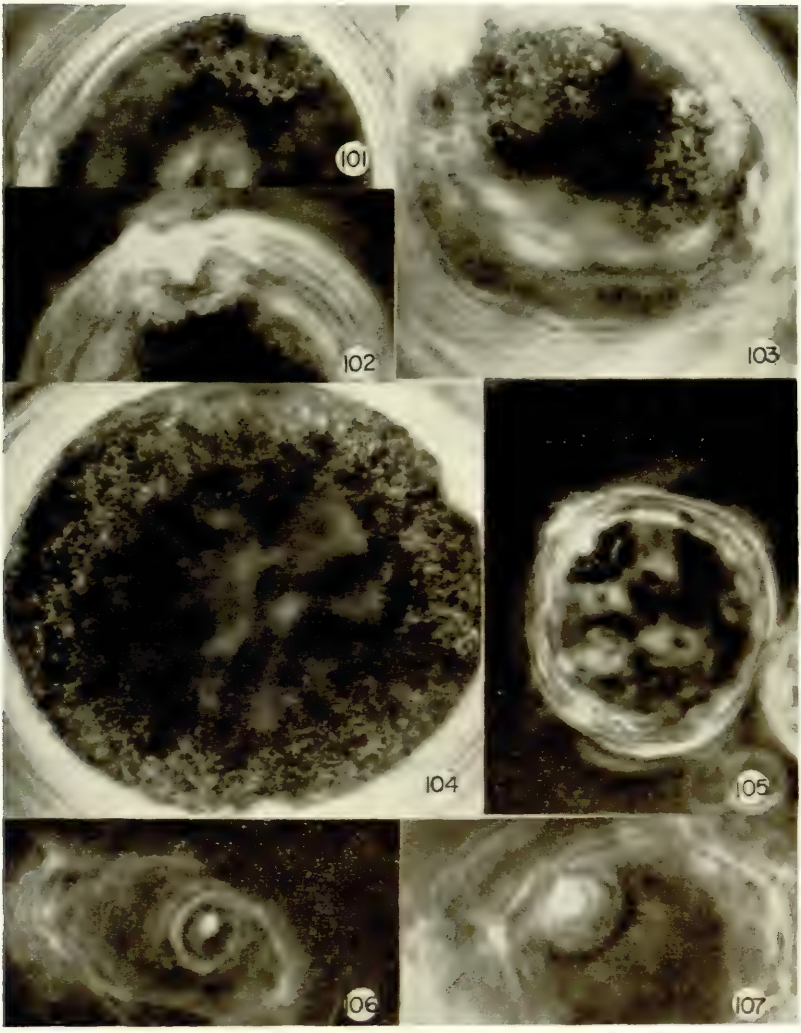


TEXT-FIGURES 92–100. Magnifications as noted. Each series (e.g., 92–94) represents successively lower levels of focus. 92–94, *Pterocarya delavayi*, polar view of heteropolar grain with seven pores. 690 ×. 95–97, *Pterocarya stenoptera*, fused grains. 690 ×. 98, 99, *Pterocarya stenoptera*, polar view. 1380 × (note distinct scabrate sculpture). 100, same grain as in 98 and 99, phase contrast, 1380 ×.

genera must be studied before this possibility can be ruled out. On the basis of the material investigated, it is apparent that the grains of *Alfaroa* are distinguishable from at least one of the three *Engelhardia* pollen types (the *E. chrysolepis* type) and may be distinguishable from another (the *E. spicata* type). However, grains of *Alfaroa* and the *Engelhardia nudiflora* type appear to be indistinguishable. Pollen grains of the *E. chrysolepis* type are much smaller than those of *Alfaroa* (14.4 vs. 23.0 micra), are distinctly triangular (vs. rounded-triangular), are oblate (vs. suboblate), have an equatorially elongated endopore (vs. a circular one), the ektexine does not thicken within the vestibulum, and columellae cannot be differentiated (they are visible within the thickened ektexine of the vestibulum in *Alfaroa* grains). The distinctions between *Alfaroa* grains and those of the *E. spicata* type are by no means so certain, partly because it is not clear whether the *E. spicata* type represents a distinct "species" or rather an anomalous variant of the *E. nudiflora* type. Grains of the *E. spicata* type tend to be more spheroidal, the vestibulum is often less distinct, and the exine is often sharply undulating, perhaps due to an unevenly thickened ektexine.

The grains of *Juglans* and *Pterocarya* are very similar. The variational extremes appear to be relatively distinct (e.g., tetra- and pentaporate, stephanoporate grains of *Pterocarya* and periporate, heteropolar grains of *Juglans* (§ RHYSOCARYON and § DIOSCARYON). However, as is evident from the scatter diagram, the photomicrographs, and the data presented in TABLES 5, 6, and 7, there is a variational continuum from *Pterocarya* to *Juglans* section CARDIOCARYON. Pore number, grain size, and frequency of heteropolar grains tend to be higher in section CARDIOCARYON, but there is overlap for all of these characteristics. Pollen size cannot be used because there is a general correlation between pollen size and pore number; those grains of *Juglans* (§ CARDIOCARYON) with the lowest pore number are also smallest. Furthermore, the heteropolar tendency is detectable in many stephanoporate *Pterocarya* grains in that one pore is apt to be positioned slightly off of the equator and the grains are often somewhat plano-convex in equatorial view. Other morphological criteria are equally difficult to apply. The pore aperture in *Pterocarya* is apt to be elongated meridionally, but this is by no means constant. *Pterocarya* grains are generally more oblate in shape, but this characteristic is associated with pore number and degree of heteropolarity; heteropolar grains are more spheroidal (and stephanoporate-isopolar *Juglans* grains are more oblate than heteropolar ones). The polar ektexinous thinning is not a definitive characteristic, because it is not present in stephanoporate *Juglans* grains, and is extremely difficult to detect (and possibly absent) in many heteropolar grains with relatively low pore number. There are no apparent differences in columella distribution.

Grains with from 6 to 8 pores are extremely difficult to identify with certainty. However, certain suggestions can be made on the basis of the data presented in TABLE 7 and FIGURE 109. It can be seen that five- and six-pored grains are much more frequently encountered in *Pterocarya,*



TEXT-FIGURES 101–107. Phase contrast photomicrographs. Magnification 1420 ×. 101. *Carya sinensis*, pore area (note restricted vestibulum, sharp vestibular boundary, widely scattered columellae within vestibulum). 102. *Carya tonkinensis*, pore area (note restricted vestibulum, sharp boundary). 103. *Carya cordiformis*, equatorial view, ektexinous thickening extensive, reaching far beyond vestibulum. 104. *Carya tomentosa*, polar view, columellae evident throughout equatorial region, including interporium. 105. *Engelhardia parvifolia*, polar view (note presence of columellae along "ridges" on grain surface). 106. *Pterocarya delavayi*, equatorial view of pore, note vestibulum relatively free of columellae. 107. *Juglans major*, pore area (note "concentric" arrangement of columellae within vestibulum, here concentrated around endopore).

that seven-pored grains are met with frequently in both taxa, and that eight- and nine-pored grains are much more common in members of *Juglans* section CARDIOCARYON. Furthermore, there is an obvious difference between taxa within each pore-number class, since the frequency of stephanoporate grains is consistently higher in *Pterocarya*. For example, 97 per cent of hexaporate *Pterocarya* grains are stephanoporate, and only 44 per cent of *Juglans* (§ CARDIOCARYON) grains; and 71 per cent of seven-pored *Pterocarya* grains are stephanoporate, 4 per cent of *Juglans*.

Such data are instructive, but must be handled with extreme caution, since a number of assumptions are involved. First, when dealing with fossil material, it would be necessary to assume that the populations of *Juglans* and *Pterocarya* which contributed pollen to the depositional basin in question possessed pore-number and heteropolar-frequency characteristics comparable to those determined in the present study. Secondly, since relatively few collections were studied, there is no guarantee that the data are representative for the two taxa. Furthermore, it is quite possible that significant interspecific and intraspecific differences in populations may exist for both characteristics (this could apply to both modern and fossil material). This possibility can be visualized from the histograms for extreme individual collections which are also presented in TEXT-FIGURE 2. (This should not be construed as proof of the existence of such differences in populations, merely as a hypothetical example.) If, for example, the populations of *Juglans* and *Pterocarya* growing in the vicinity of a depositional basin possessed frequency characteristics similar to those of the individual collections of *Juglans cinerea* and *Pterocarya rhoifolia*, separation of grains would be virtually impossible. On the other hand, the presence of populations with characteristics approximating those for *Juglans sieboldiana* and *Pterocarya insignis* would make discrimination considerably easier. A further complication is that the distributions (for pore number and frequency of heteropolar grains) determined in the present study may be derived, the result of a long evolutionary sequence. It seems probable that within the *Juglans-Pterocarya* complex small pollen size, low pore number and low frequency of heteropolar grains are primitive characteristics. Hence one would expect *Juglans* section CARDIOCARYON grains from the early Tertiary to have characteristics more closely approximating those of modern *Pterocarya* species. Similarly, one might expect lower pore number within the early Tertiary species of *Pterocarya*.

It must be concluded that individual *Pterocarya-Juglans* section CARDIOCARYON grains will pose a difficult problem. If such grains are sufficiently common, it would be instructive to prepare a statistical analysis of pollen size, pore number, and frequency of heteropolar grains. This would allow more reasonable suggestions as to the taxa involved and provide a more meaningful basis for the delimitation of form genera and form species.

Subgeneric categories. The degree to which subgeneric identifications can be made is suggested by the following key to generalized pollen types. It should be emphasized that specific identifications are not im-

TABLE 7. **Pore-number and heteropolar grain frequency in Juglans § Cardiocaryon and Pterocarya**

	JUGLANS § CARDIOCARYON *									PTEROCARYA **													
PORE-NUMBER	*sieboldiana*	*cathayensis*	*cathayensis*	*mandshurica*	*cinerea*	*cinerea*	TOTALS	$\bar{x}$	% STEPH. (OF CLASS)	*paliurus*	*rhoifolia*	*rhoifolia*	*fraxinifolia*	*fraxinifolia*	*insignis*	*delavayi*	*hupehensis*	*stenoptera*	*stenoptera*	TOTALS	$\bar{x}$	% STEPH. (OF CLASS)
3						1^1	1^1	0.4	100	2										2	0.4	100
4							0	0.0	(100)	39			1		1	2	1			44	8.8	100
5			1^1		1^1	1^1	3^3	1.2	100	9	8	1	32	3	33	16	30	6	3	141	28.2	100
6	2^2	3^1	11	1^1	4^4	2^2	23^{10}	9.2	43.5		25	13	17^2	34	15	23^3	18	27	22	194^5	38.8	97.4
7	8	20	21	9	12^3	10	80^3	32.0	3.8		14^{11}	32		11^1	1^1	9^9	1^1	12	20^5	100^{29}	20.0	71.0
8	20	22	11	22	6	7	88	35.2	0.0		3^3	4^2		2^9				4	5^5	18^{12}	3.6	33.0
9	13	4	5	12	2	3	39	15.6	0.0									1^1		1^1	0.2	0.0
10	6	1	1	5		1	14	5.6	0.0											500^{47}		
11	1			1			2	0.8	0.0													
							250^{17}															

* exponent indicates number of stephanoporate grains

** exponent indicates number of heteropolar grains

plied; each pollen type may include a number of different species. In some cases only the variational extremes can be separated from closely related types. As the range of variation has been considered in preparing the key, many taxa may be keyed out at several points (e.g., *Pterocarya* under triporate, stephanoporate, and periporate-heteropolar). The size criteria apply *only* to modern material prepared as outlined previously and mounted in silicone oil. Correction factors must be employed for fossil material and modern grains prepared by different techniques. The pollen-shape classes can be used only for fully expanded grains that have not been compressed either by fossilization or pressure from the coverslip.

1. Grains triporate (occasionally diporate).
   2. Grains isopolar.
      3. Pseudocolpi present. ..... *Platycarya* type.
      3. Pseudocolpi absent.
         4. Grains $> 26\mu$; pores aspidate, columellae within slightly thickened ektexine of vestibulum clear, often concentrated around exopore and endopore. ..... *Pterocarya-Juglans* § *Cardiocaryon* type.
         4. Grains $< 26\mu$; pores very slightly to not at all aspidate; columellae not visible, or visible and tightly packed within vestibulum.
            5. Grains $12–17\mu$; triangular; oblate; exopore meridionally elongated; endopore equatorially elongated; columellae not visible. ..... *Engelhardia chrysolepis* type.
            5. Grains $17–26\mu$; rounded-triangular to circular; suboblate to oblate-spheroidal; exopore and endopore more or less circular; columellae visible within vestibulum.
               6. Exine of uniform thickness, grain outline smooth. ..... *Engelhardia nudiflora-Alfaroa* type.
               6. Exine unevenly thickened, grain with undulating outline. ..... *Engelhardia spicata* type.
   2. Grains heteropolar (pores positioned off of the equator toward one pole, ektexinous thinning of pore-free (proximal) pole).
      7. Grains $< 33\mu$; relatively isopolar; vestibulum and ektexinous thickening restricted; sharp line of demarcation between vestibulum and exine of polar hemisphere. ..... *Carya tonkinensis-sinensis* type.
      7. Grains $> 33\mu$; strongly heteropolar; vestibulum and ektexinous thickening less restricted; demarcation between vestibulum and polar region apt to be gradational. ..... *Carya* type.
1. Grains with more than 3 pores.
   8. Grains stephanoporate (isopolar); 4–7 pores.
      9. Pseudocolpi present. ..... *Platycarya* type.
      9. Pseudocolpi absent.
         10. Grains $> 26\mu$; pores aspidate; columellae within vestibulum clear, often concentrated around exopore and endopore; grains angular in outline. ..... *Pterocarya-Juglans* § *Cardiocaryon* type.
         10. Grains $< 26\mu$; pores slightly to not at all aspidate; columellae not visible, or visible within vestibulum (and there tightly packed); outline angular or rounded angular.
            11. Grains $12–17\mu$; angular (square, pentagonal); oblate; exopore meridionally elongated, endopore equatorially elongated; columellae not visible. *Engelhardia chrysolepis* type.

11. Grains 17–26μ; rounded angular to circular; suboblate to oblate-spheroidal; exopore and endopore more or less circular; columellae visible within vestibulum.
    12. Exine of uniform thickness, grain outline smooth. ..... *Engelhardia nudiflora-Alfaroa* type.
    12. Exine unevenly thickened; grains with undulating outline. ..... *Engelhardia spicata* type.

8. Grains heteropolar.
    13. Pores positioned off of the equator towards one pole, but none global (hence grains not periporate-heteropolar); pores not strongly aspidate; wall relatively thick. ..... *Carya* type.
    13. Grains periporate-heteropolar (possessing at least one global pore); pores often strongly aspidate; wall comparatively thin.
        14. Pores 9 or fewer. *Pterocarya-Juglans* § *Cardiocaryon* type. (Grains less than 30μ are more apt to be *Pterocarya*).
        14. Pores more than 9.
            15. Pores more than 19. ..... *Juglans nigra* type.
            15. Pores less than 19.
                16. Grains more than 40μ. ..... *Juglans regia* type.
                16. Grains less than 40μ. .. *Juglans* § *Rhysocaryon* type.

When one disregards the variational extremes for all taxa and considers only the most frequently occurring values for both quantitative and qualitative characteristics, it is clear that a more precise subdivision of some of the pollen types is possible. While little can be done with *Engelhardia-Alfaroa* and *Platycarya* poses no problem, more precise assignments can be made within the *Juglans-Pterocarya* complex. Pollen morphology could also be of considerable use within *Carya*, but is more difficult to employ.

The following suggestions can be made with respect to the *Juglans-Pterocarya* complex. Stephanoporate grains (3–7 pores) are most probably those of *Pterocarya*; especially those that are less than 32μ in size. Periporate-heteropolar grains with low pore number (6–9) are apt to be from *Juglans* section CARDIOCARYON (generally 33–39μ in size). Periporate-heteropolar grains with from 9 to 13 pores and of relatively small size (30–35μ) may belong to the tropical American complex (*J. australis*, *J. boliviana*, *J. insularis*, *J. neotropica*, and *J. olanchana*). Somewhat larger grains (33–39μ) with from 9 to 16 pores can be assigned to *Juglans* section RHYSOCARYON. Grains with more than 16 pores are those of *Juglans nigra* (size: 33–36μ). Grains larger than 39μ with from 11 to 15 pores are those of *Juglans regia*.

In addition, a few generalizations can be made concerning *Carya* pollen. First, it is obvious that there is a correlation between pollen size and ploidal level (Stone, 1961, 1963; Whitehead, 1963). In general the smallest grains occur in the diploids of section APOCARYA, the largest in the tetraploids of section CARYA. There are obvious exceptions. For example, *Carya illinoensis* (2*n*) of section APOCARYA has rather large grains (mean = 46.1μ) and *Carya floridana* (4*n*) of section CARYA has rather

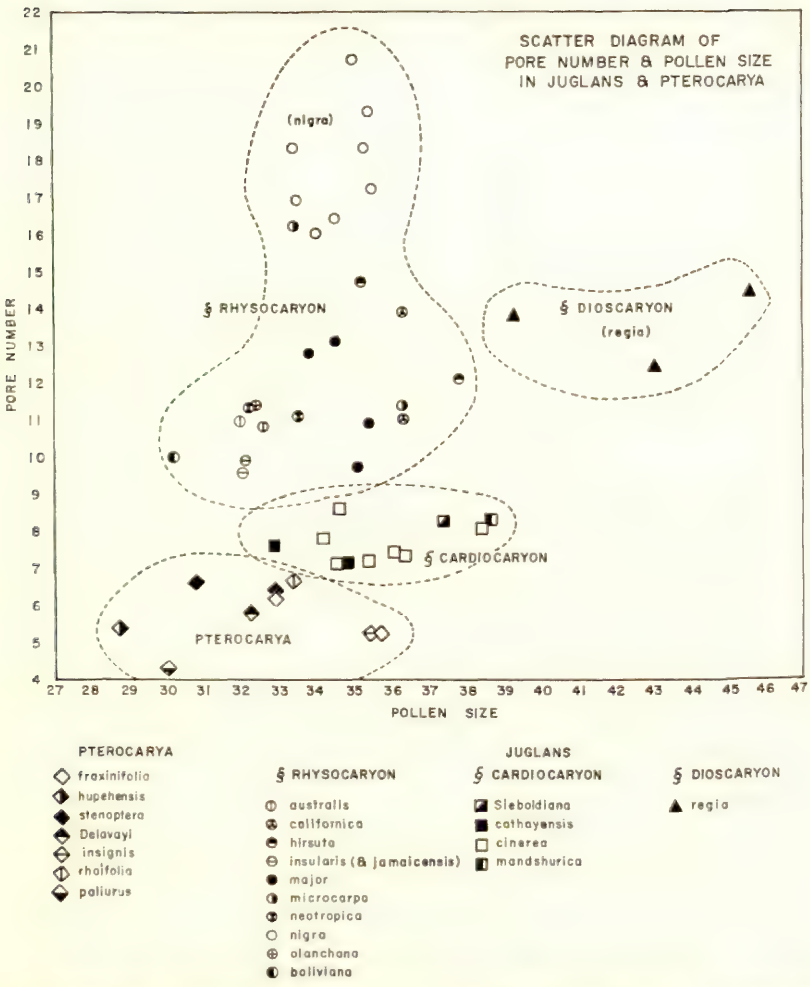


FIGURE 108. Scatter diagram of pore-number and pollen-size in *Juglans* and *Pterocarya*.

small pollen (reported by Stone (1963)) to be 44.1μ. This latter mean is from fresh grains mounted in cotton-blue-lactophenol. By applying a correction factor of — 1.03, it can be suggested that it would correspond to 42.8μ for grains treated as in the present study. Small grains are also found in *Carya sinensis* of section RHAMPHOCARYA.

Relatively isopolar grains have been observed in *Carya tonkinensis*, and *Carya illinoensis* and in *C. sinensis*. As is mentioned previously, this is a difficult criterion to employ, since it can be influenced profoundly by the state of compression of the grains.

Some species possess grains with a sharply defined and somewhat re-

stricted vestibular area. In such grains there is an abrupt change from the homogeneous exine of the general grain surface (within which columellae are not detectable) to the vestibular zone, within which columellae are distinct and irregular in size, shape, and distribution. The condition is most prevalent in a few species of section Apocarya (*C. aquatica* (one collection does not show it), *C. illinoensis*, and *C. tonkinensis*). It has also been found in *Carya texana* (§ Carya) and *C. sinensis*. The vestibular zone is also sharply defined in *Carya cordiformis* (§ Apocarya), but in that species the ektexinous thickening (the zone within which the columellae can be recognized) is extraordinarily extensive, encroaching upon both interpore area and pole.

In a few species there was a rather distinctive thickening of the ektexine within the vestibulum. This was found in both collections of *Carya*

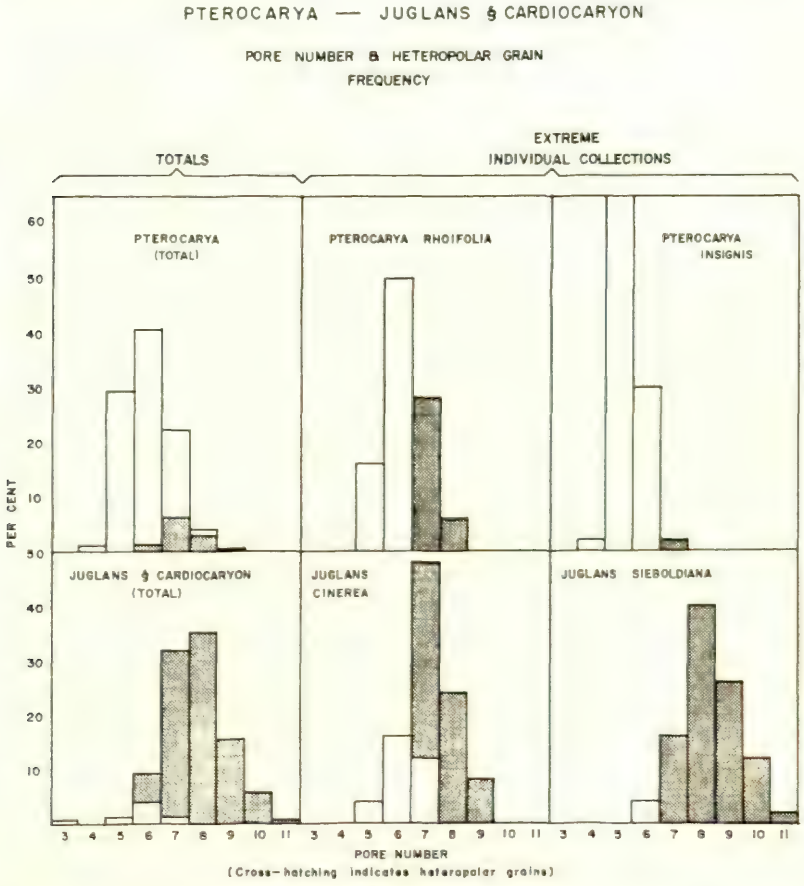


Figure 109. *Pterocarya-Juglans* § *Cardiocaryon*: pore-number and heteropolar grain frequency.

illinoensis and the single collection of *Carya pallida* (§ CARYA). It has also been reported for the latter species by Stachurska (1961).

The pollen grains of *Juglans regia* and *Carya illinoensis* are of further interest because of their relatively large size. The mean for *Juglans regia* (43μ) is considerably larger than that for other species of the genus (means usually 32–36μ) and the grains of *C. illinoensis* (mean = 46μ) are much larger than those of other species of section APOCARYA and as large as those of the tetraploids of section CARYA. Stone (1963) has also noted this for *C. illinoensis*, and has suggested that large grain size might be correlated with increased fertility, as is the case in other taxa. It is significant that both of these species have had a long history of cultivation; hence the recent evolutionary trends within the species may be largely controlled by the selective pressures imposed by man. Certainly increased fertility would be selected for, and if pollen grain size were correlated, as seems likely, it is reasonable to suggest that the evolution of larger pollen in these taxa has been a relatively recent phenomenon, stimulated and directed by man's practices.

Phylogenetic considerations. Pollen morphology supports the indications from floral morphology (Manning, 1938, 1940, 1948) and wood anatomy (Heimsch & Wetmore, 1939) as to relationships of genera. The correlated evidence from these previous studies indicates that the *Engelhardia-Alfaroa* complex (see also Manning, 1949) is primitive and that the *Juglans* and *Carya* lines are relatively advanced. *Pterocarya* appears to occupy an intermediate position, relatively close to *Juglans*. *Platycarya* presents some interesting problems, being advanced with respect to wood anatomy (Heimsch & Wetmore, loc. cit.) and primitive with respect to type and bearing of inflorescence (Manning, 1938).

When speculating on the evolution of pollen types within the family, it would be reasonable to look for the most primitive grains within the *Engelhardia-Alfaroa* group and the most advanced in *Juglans* and *Carya* (and *Platycarya*?). The grains of the *Engelhardia-Alfaroa* are small, prevailingly triporate, and isopolar; those of *Juglans* and *Carya* larger, heteropolar, possess an ektexinous thinning on the proximal pole, and, in the case of *Juglans*, have a higher pore number. It would thus appear that the primary evolutionary trends have involved an increase in pore number, grain size, and heteropolarity. To some extent these trends have been independent of one another. The general trends are indicated in FIGURE 110.

Within *Engelhardia* and *Alfaroa* there are at least two pollen types represented: first, the very small, triangular, oblate *E. chrysolepis* type, secondly, the larger, more spheroidal *E. nudiflora-Alfaroa* type. The *E. spicata* type is problematical, and may be nothing more than an aberrant variant of the basic *E. nudiflora* type. For the moment it will be disregarded. On the basis of wood anatomy (Heimsch & Wetmore, 1939) and floral morphology (Manning, 1938, 1949) *Alfaroa* appears to be the most primitive member of the family. It would then be logical to suggest that

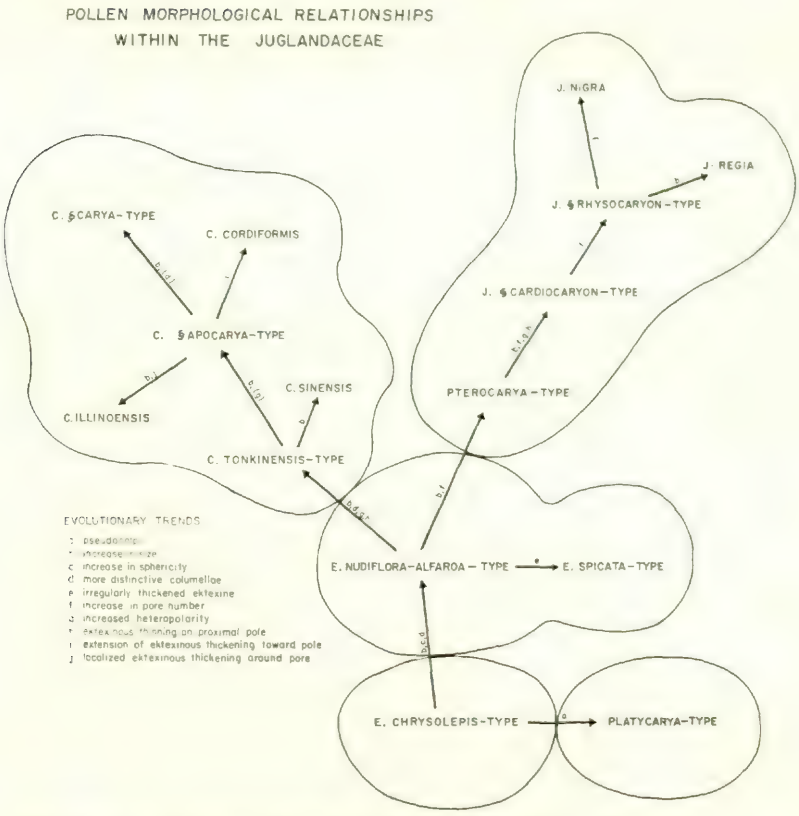


FIGURE 110. Pollen morphological relationships within the Juglandaceae.

pollen grains of the *E. nudiflora-Alfaroa* type, found also in this genus, are the most primitive, and that the *E. chrysolepis* type has been derived through a reduction in pollen size, increasing angularity, and reduction of columellae. However, there are several arguments against this view. First the general trend within the family appears to have been an increase in grain size and an increase in the distinctiveness of columellae. The evolution of the *E. chrysolepis* type from the *E. nudiflora-Alfaroa* type would require a reversal of this. Secondly, the remarkable similarity of *Platycarya* and *E. chrysolepis* type pollen may be of significance. Should *Platycarya* grains lack pseudocolpi, they would be virtually indistinguishable from those of the *E. chrysolepis* type. Both grains are extremely small, triangular, oblate, have a meridionally elongated exopore and an equatorially elongated endopore, and a homogeneous exine (it does not thicken within the vestibulum and no columellae can be differentiated). The scabrate sculpture of both types is extremely fine (a function of grain size) and uniform. All these features suggest that the *Platycarya* type has evolved from the *E. chrysolepis* type through the development of localized

arcuate thinnings of the ektexine (reduction of columella layer and inner tectum). Should this suggestion be valid, then it is more logical to assume that the *E. chrysolepis* type is primitive, and that the *Platycarya* and *E. nudiflora-Alfaroa* types are evolved (also the *E. spicata* type). In this context, it is perhaps significant that both *Platycarya* and *Engelhardia chrysolepis* possess inflorescence types (terminally placed androgynous panicles) which Manning (1938) considers to be the most primitive for the family.

From the triporate-isopolar base there were apparently two primary evolutionary lines, one involving increase in grain size and heteropolarity (culminating in the grains of *Carya* section CARYA), the other, involving increase in pore number, increase in grain size, and heteropolarity, leading through *Pterocarya* and culminating in *Juglans nigra* (high pore number) and *Juglans regia* (large pollen grains).

It is difficult to ascribe evolutionary significance to the pollen morphological characteristics observed within the genus *Carya*, since the features are subtle and display great variation. However, it is probable that the most primitive grains would be those most closely approximating the *Engelhardia-Alfaroa* type, i.e., small size, relative isopolarity, restricted ektexinous thickening and vestibulum. Such grains are found in various species of section APOCARYA and also in *Carya sinensis* (§ RHAMPHOCARYA). The grains of *Carya tonkinensis* and *C. sinensis* are more similar to those of *Engelhardia-Alfaroa* than those of other species, hence may represent the most primitive type. This situation is not unexpected, since preliminary evidence indicates that species of section APOCARYA are primitive (Stone, 1962) and that *Carya tonkinensis* may be the most primitive. Wood of this species is less distinctly ring porous and possesses more heterogeneous rays than that of other species (Heimsch & Wetmore, 1939). More recently (Leroy, 1953) it has been shown that the wood of *Carya sinensis* is virtually indistinguishable from that of *C. tonkinensis*.

The larger, more heteropolar grains of section CARYA, especially those of the tetraploids, can be considered more advanced. The recognizable variants of the APOCARYA type (e.g., *C. cordiformis* and *C. illinoensis*) are doubtless short side lines.

The last pollen type to be considered is that found in *Juglans* and *Pterocarya*. Following the evolutionary sequence suggested for the family as a whole it seems probable that the relatively small stephanoporate grains of *Pterocarya* are more primitive than those of *Juglans*. This is in harmony with the intermediate position suggested by morphological and anatomical studies (Heimsch & Wetmore, 1939; Manning, 1938).

Since there appears to be a continuum between *Pterocarya* and *Juglans*, it is interesting to speculate on the relationship of these genera. On the basis of pollen morphology alone the relationship would appear to be close. This is also suggested by wood anatomy (Heimsch & Wetmore, 1939) and floral morphology (Manning, 1938, 1940, 1948). The present study indicates that the relationship is closest between species of the section CARDIOCARYON and *Pterocarya* (see, for example, the scatter diagram).

This alliance is also supported by the evidence from wood anatomy and floral morphology. Heimsch and Wetmore (loc. cit.) have noted that species of *Cardiocaryon* have vascular elements with thinner walls than those of other species in the genus as a whole. This condition is similar to that prevailing in *Pterocarya*. Furthermore, species of section CARDIOCARYON differ from the rest of the genus in possessing more flowers (12–20) per pistillate catkin (Manning, 1938) and fewer stamens (7–18) per staminate flower (Manning, 1948). In both of these characteristics the section CARDIOCARYON resembles *Pterocarya*. In addition, there is a similarity between the two taxa in the number of bracts, bracteoles, and sepals in both staminate and pistillate flowers (Manning, 1940, 1948). Thus evidence from a variety of lines suggests a close relationship between *Juglans* and *Pterocarya* and most particularly between *Juglans* section CARDIOCARYON and *Pterocarya*.

Following this line of reasoning, it is suggested that the scatter diagram (FIGURE 108) depicts the evolutionary trends within the *Juglans-Pterocarya* complex. The base of the sequence is occupied by the "Pterocaryoid" grain of relatively small size, low pore number, and high frequency of isopolarity. The "Cardiocaryoid" type can be derived from this by an increase in pollen size, pore number and heteropolarity. The evolution of the "Rhysocaryoid" type of grain from the latter simply involves an increase in pore number. From the "Rhysocaryoid" type there were apparently two independent evolutionary lines, the first involving an increase in pore number and culminating in *Juglans nigra*, the second involving a stabilization of pore number and an increase in pollen size (culminating in *Juglans regia* (§ DIOSCARYON)). The relatively isolated position occupied by the tropical American species of section RHYSOCARYON (*J. olanchana*, *J. neotropica*, *J. insularis*, *J. australis*) might suggest an early time of isolation from the main RHYSOCARYON line, and the retention of relatively "primitive" characteristics (low pore number and small pollen size).

The evolutionary trends outlined here are summarized graphically in FIGURE 110. This is designed only to portray the evolution of pollen types, not necessarily the relationships of extant taxa. The two may well be parallel (as seems to be the case within the *Juglans-Pterocarya* complex), but obviously such phylogenetic speculations must involve a consideration of all data bearing upon the problem.

SPECIMENS EXAMINED [2]

1. **Alfaroa costaricensis** Standley var. **costaricensis**. COSTA RICA: *Skutch 4684* (A).
2. **Alfaroa costaricensis** Standley var. **elongata** Manning. COSTA RICA: *Skutch 4685* (A).

[2] Material studied was obtained from the herbarium of the Arnold Arboretum (A), the Gray Herbarium (GH), the Botanical Museum, Copenhagen (C), the U.S. National Herbarium (US), the herbarium of Bucknell University (BU), and the Instituto Interamericano de Ciencias Agricolas (IICA). DGU numbers refer to slides in the reference collection of the Geological Survey of Denmark.

3. **Alfaroa manningii** León. COSTA RICA: *León 3331* (BU).
4. **Engelhardia apoensis** Elmer ex Nagel. BORNEO: *Kostermans 7417* (US).
5. **Engelhardia nudiflora** Hook. f. MALAYA: *Haniff*, 1928 (C; DGU — 2865).
6. **Engelhardia parvifolia** C. DC. PHILIPPINES: *Ramos & Edaño 28761* (A).
7. **Engelhardia serrata** Bl. var. **cambodica** Manning. CHINA: *Henry 11774* (A).
8. **Engelhardia spicata** Bl. INDIA: *Hooker & Thomson*, no date (C; DGU — 3916).
9. **Engelhardia spicata** Bl. var. **acerifolia** (Reinw.) Koorders & Valeton. CHINA: *Ko 55858* (A).
10. **Engelhardia spicata** Bl. var. **colebrookiana** (Lindl. ex Wall.) K. & V. INDIA: *Abraham 87?* (C; DGU — 3910).
11. **Engelhardia chrysolepis** Hance (= *E. roxburghiana* Wall.). CHINA: *Steward & Cheo 584* (A); *Ching 1980* (A). VIETNAM: *Collector unknown* (C; DGU — 2915).
12. **Engelhardia pterocarpa** (Oerst.) Standl. COSTA RICA: *León 1819* (IICA).
13. **Platycarya strobilacea** Sieb. & Zucc. JAPAN: *Uno*, 1952 (A). KOREA: *Tacquet 3113* (A).
14. **Carya glabra** (Mill.) Sweet. (Specimens cited in: Whitehead, 1963).
15. **Carya laciniosa** (Michx. f.) Loud. (Specimens cited in: Whitehead, 1963).
16. **Carya leiodermis** Sarg. (Specimens cited in: Whitehead, 1963).
17. **Carya ovalis** (Wang.) Sarg. (Specimens cited in: Whitehead, 1963).
18. **Carya ovata** (Mill.) K. Koch. (Specimens cited in: Whitehead, 1963).
19. **Carya pallida** (Ashe) Engl. & Graebn. (Specimens cited in: Whitehead, 1963).
20. **Carya texana** Buckl. (Specimens cited in: Whitehead, 1963).
21. **Carya texana** Buckl. var. **arkansana** Sarg. (Specimens cited in: Whitehead, 1963).
22. **Carya tomentosa** Nutt. (Specimens cited in: Whitehead, 1963).
23. **Carya tomentosa** Nutt. var. **subcoriacea** Sarg. (Specimens cited in: Whitehead, 1963).
24. **Carya aquatica** Nutt. (Specimens cited in: Whitehead, 1963).
25. **Carya cordiformis** (Wang.) K. Koch. (Specimens cited in: Whitehead, 1963).
26. **Carya cordiformis** (Wang.) K. Koch. var. **latifolia** Sarg. (Specimens cited in: Whitehead, 1963).
27. **Carya illinoensis** (Wang.) K. Koch. (Specimens cited in: Whitehead, 1963).
28. **Carya myristiciformis** (Michx. f.) Nutt. (Specimens cited in: Whitehead, 1963).
29. **Carya tonkinensis** Lecomte. CHINA: *Tsai 53190* (A).
30. **Carya sinensis** Dode. INDOCHINA: *Pételot 6376* (A).
31. **Pterocarya paliurus** Batalin. CHINA: *Wilson 901* (A).
32. **Pterocarya fraxinifolia** (Lam.) Spach. PERSIA: *Sintenis 1348b* (A). Locality unknown: *E. Koehne*, no date (C; DGU — 3936).
33. **Pterocarya hupehensis** Skan. CHINA: *Wilson 404* (A).
34. **Pterocarya stenoptera** C. DC. CHINA: *Sun 1091* (A); *Handel-Mazzetti 11580* (C; DGU — 3941).
35. **Pterocarya delavayi** Franchet. CHINA: *Ching 20475* (A).
36. **Pterocarya insignis** Rehd. & Wils. CHINA: *Schneider 930* (A).
37. **Pterocarya rhoifolia** Sieb. & Zucc. JAPAN: *Tschonoski 1864* (GH); *Faurie*, 1904 (A).
38. **Juglans australis** Griseb. ARGENTINA: *Peirano 18700* (GH); *Schreiter 1045* (BU).

39. **Juglans boliviana** (C. DC.) Dode. PERU: *Knowles*, 1956 (BU).
40. **Juglans californica** S. Wats. U.S.A.: *Clokey & Templeton 4465* (GH); *Parish 6908* (A).
41. **Juglans hirsuta** Manning. MEXICO: *Pringle*, 1906 (GH); *Mueller & Mueller 428* (A).
42. **Juglans insularis** Griseb. CUBA: *Rehder 1157* (A).
43. **Juglans jamaicensis** C. DC. CUBA: (cultivated) *Walsingham*, 1948 (BU).
44. **Juglans major** (Torr.) Heller. U.S.A.: *Gillespie 5665* (GH). *Lowell*, 1911 (A); *Eastwood 8387* (A); *Skehan 29* (A).
45. **Juglans microcarpa** Berl. U.S.A.: *Palmer 11327* (A); *Greene*, 1880 (A).
46. **Juglans neotropica** Diels. ECUADOR: *Rose 22807* (GH). PERU: *Vargas 7409* (BU).
47. **Juglans nigra** L. (Specimens for pore number study cited in: Whitehead, 1963). U.S.A.: *Biltmore Herbarium 1314* (A); *Thomas 2148a* (A); *Drushel*, no date (C; DGU — 3928).
48. **Juglans olanchana** Standley & Williams. SAN SALVADOR: *Calderon 1528* (GH).
49. **Juglans regia** L. CHINA: *Steward & Cheo 86* (A); *Simeon 334* (A); *Chiao*, 1926 (C; DGU — 3865).
50. **Juglans sieboldiana** Maxim. JAPAN: *Funu Agric. Coll.*, 1885 (A).
51. **Juglans cathayensis** Dode. CHINA: *Wilson 371a* (A); *Yü 411* (A).
52. **Juglans cinerea** L. (Specimens for pore number study cited in: Whitehead, 1963). U.S.A.: *Deane*, 1886 (GH); *Williams*, 1897 (GH).
53. **Juglans mandshurica** Maxim. MANCHURIA: *Komarov 463* (A).

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DEPARTMENT OF BIOLOGY
WILLIAMS COLLEGE
WILLIAMSTOWN, MASSACHUSETTS

LETTERS FROM CHARLES SPRAGUE SARGENT TO REGINALD SOMERS COCKS, 1908–1926 *

Edited by JOSEPH EWAN

239

March 26, 1920.

Please collect for us as many specimens as you can of the Azaleas which have passed as *nudiflora*. Apparently this species does not get into Louisiana at all. The specimens which we collected at Winnfield April 6, 1913, Palmer's 8882 and 9462 from Natchitoches, one specimen which we collected April 12, 1915, at Lakes Charles and one which I collected in 1885 at Pineville belong to *Azalea canescens*. There appears to be a distinct form of this last in Mississippi, Louisiana and Texas differing in the glabrous under surface of the leaves and more slender corollas. This is Palmer's Natchitoches specimen 7228 and the plant with white flowers which we collected at Lake Charles April 2, 1913. So far as we know now this form always has white flowers, or nearly white flowers, and grows in swamps or on the borders of swamps.

The specimens which I have enumerated are the only ones we have from Louisiana. I suspect that this new form, which will probably have to be treated as a variety of *canescens*, grows in eastern Louisiana as it seems to be common and the only form in southern Mississippi. We have specimens, however, of no early-flowering *Azalea* from eastern Louisiana. Please look out for this this spring as we are working here on a monograph of American species. The only Azalea from eastern Louisiana which we have is what has passed for *Azalea viscosa*. It is not that species which does not get south at all, but Small's *Azalea serrulata* which grows from central Florida through southern Mississippi to eastern Louisiana.

I wonder if we are going to live long enough to get the trees and shrubs from Louisiana properly straightened out. I hope you will do what you can in this Azalea business this spring and send us as much material from as many localities as possible.

240

April 8, 1920.

I read in a Boston paper that Louisiana is to be hunted from end to end for a mysterious species of *Aronia* and for an Ash-tree, and that the New Orleans Garden Club has been called on by Harvard to perform this service, so I suppose great results can be expected. In the meantime I wish you would dry for me flowers of as many of the different Azaleas cultivated in the old Louisiana gardens as you can reach. We are making here a

* Continued from volume 46, p. 361.

systematic study of the Azaleas of eastern Asia which have been in a helpless state of confusion, especially cultivated plants, and we are interested to know if possible which were the Azaleas cultivated in the southern states.

On the Butler place I made a couple of specimens which turned out to be *Azalea ledifolia* but there are probably other species cultivated. From the specimens we shall be able to name the species at least to which the plants belong. I should think that this would be a subject in which the members of your Garden Club would be interested; still if they want to hunt swamps for a missing Ash-tree I would not discourage them.

241

April 16, 1920.

I have this morning your letter of April 12th. Do not forget that *Crataegus silvicola* Beadle grows in eastern Louisiana. Unfortunately I have had to change the name of *drimophila* because there is an older *Crataegus silvicola* published in Europe.

It is much more than two years since I have heard from your lady friend in Crowley.[21] She did send me some May Haws but I can hardly believe that I told her the May Haw had practically disappeared from western Louisiana where it seems to be more abundant than anywhere else.

Is there any reason why Azaleas should not grow in New Orleans gardens? They certainly do well in West Feliciana Parish, at the Butler place and at Natchez. We are taking a good deal of interest in these plants now and are beginning to print a book about all the Azaleas in the world. I should like to send you some plants in the autumn for your friends if there is a chance of their doing well in Louisiana. Azaleas would certainly do well, I should say, in the Selma region.

We are still having very bad weather and although the frost is all out of the ground spring is not making much headway. I noticed this morning that the buds of *Dirca palustris* were just beginning to open.

Hope to hear from you soon.

242

May 27, 1920.

The evergreen plant of which you send me a fragment is *Cocculus laurifolius*[22] from southern China. The package with *Azaleas*, etc., was duly received. These appear to be all *Rhododendron canescens* but you will know more about them later. Rehder's present theory is that *nudiflorum* is not a southern plant at all.

I am horrified at what you write about *Adelia* fifty feet high and a tree. If your plant is really a tree how can it be kept out of my Manual? I have seen thousands of these *Adelias* in different parts of the country and growing under favorable conditions. They were never trees in the true sense of the word, that is with a single trunk, but really large shrubs.

[21] Presumably PHEBE SUSAN LOVELL.

[22] Introduced sometime after 1898 by Ida Richardson.

Please write me at once about your Baton Rouge specimen. If it is a tree what is the diameter of the trunk, and especially how tall is it before it begins to divide into branches? I hate the idea of putting *Adelia* in the Manual, but after the big specimens of *Styrax* we saw in West Feliciana Parish there is no knowing what may happen in western Louisiana. If *Adelia* is to be put in the Manual I ought to know about it at once.

I had yesterday a very pleasant visit from your friend Miss King who talked to me a great deal about you and your success with your Garden Club and with the ladies of New Orleans generally. She was here only a short time and I was able to show her very little of the Arboretum which she seemed to enjoy. She agreed with me that you ought not to delay much longer the publication of your Flora. You of course cannot begin to print it until you have been here for consultation with various books, specimens, etc. There is no better time for you to do this work than this summer. I expect to be here all summer and to be living alone most of the time, so come and stay with me as soon as you like and work here and in Cambridge. Do not think about this but come.

243

June 11, 1920.

I have yours of the 5th of June and read with regret what you say about the *Adelia*. How tall was the trunk with a diameter of eighteen inches, that is how soon did it begin to branch above the surface of the ground? Perhaps you can get some further information about the size of the plant on the Alabama River. I really don't want to put this plant in the new Manual but I am afraid you will compel me to do so. I will write you about your Huckleberry as soon as the specimens are mounted.

Your specimens of *Aronia* which you send me have leaves as large or perhaps even larger than the type of Hooker's variety *macrophylla*, so I suppose if you want to include this variety in your Flora you have authority to do it.

Please reconsider your assumed inability to come north this summer. You have to publish your Flora sometime and even if you should put off doing so for another fifty years it would not be complete when it was published. I do not believe it is wise to wait any longer, and you certainly cannot publish until you have come north to see various books. There is no time so good as this summer for doing this, and I think if you only stayed three or four weeks and worked hard you would do everything there was to be done here. At this end of the route there is every reason why you should come this summer and not put it off longer. It will be an awful pity if all the work you have done on the Louisiana flora was wasted, and it will be if your book is not published. Delays are fatal.

244

June 21, 1920.

I have a bundle with two specimens of *Azalea* and a *Prunus*. I understand that the *Prunus* is the plant from which you sent, in a pasteboard

box, a small quantity of fruit a few days ago. Am I right in this supposition? I do not know this Plum at all but I trust you haven't found a new species. The leaves look a good deal like those of *P. angustifolia* variety *varians* but the fruit, judging by the stone, can be no form of *angustifolia*. I should take the fruit for that of *munsoniana* which, however, does not ripen before the middle of August. As I understand it *angustifolia* ripens in Alabama by the 1st of May and the fruit of this new plant does not ripen much before the middle of June and much earlier than *munsoniana* which also grows in the Selma region.

We have in the herbarium here your Nos. vii. 1913; 15 and 16 of 1914, and 896 of 1914. These are placed under *P. munsoniana*. Do any of these numbers belong to the new tree and, if not, have you flowers to accompany the leaves and fruit sent this year? We have also Nos. 1 and 3, March 1914 which are probably *P. munsoniana*. As I understand the new tree does not sucker. Is it common and how large does it grow? I cannot bear the thought of another Plum tree.

Please answer this letter by return mail and tell me everything you know about "*Prunus Cocksii*," of which I hope there is but a single plant, in which case I won't feel like doing anything about it.

245

August 3, 1920.

I am struggling to arrange the *Prunus* material in this herbarium and to write up the genus for the Manual. The only thing I have really accomplished is to convince myself that I know nothing whatever about American Plum-trees. I have, however, made the following notes for you.

Alabama. Yellow fruit, August 20, 1918, is probably *P. umbellata*. Your leaf specimen sent in October of that year is very poor. Please press and send us others as soon as possible. Notice that the leaves are much more pubescent than those of the ordinary form of *P. umbellata*. This has always made me hesitate about this specimen.

Prunus, June 15, 1920, I suppose we must call *angustifolia varians* until we know something more about it. Please send us more herbarium material with well grown leaves. If this determination is correct the plants must be an escape from cultivation. I do not understand your fruit "in long racemes." *Prunus* never has racemose fruit.

Pine Flat near creek, No. 892. We have fruit but do not find leaf specimens. Please send these if you can find the tree.

You do not appear to have collected *Prunus americana* in the Selma district although Harbison found it there and we have several specimens from him.

Eastern Louisiana. The following I refer to *Prunus lanata*. 1 and 2, Butler Plantation, March 28, 1910. 20, West Feliciana, October 1914. Covington, March 28, 1911. Open woods, Hammond, May 13, 1910. Laurel Hill, Nos. 2 and 3, October 7, 1910. Ventries Plantation, April 27, 1910, *Prunus* No. 2, Butler Plantation, "Clover Hill, 200 feet west of pond," March 28.

Western Louisiana. *Lanata,* Palmer, Nos. 7015, 80677[sic], 7069, 8859, 7074, 7051, 8742, 7008, 8789.

To *Prunus mexicana* I refer Laurel Hill No. 4, October 7, 1910; Pineville, Cocks, September 20, 1912, a tree fifteen miles west of Opelousas, C. S. S., October 10, 1913; Ruston, Cocks, No. 6, August 24, 1914; Archibald, Cocks, No. 18, October 1910; Alto, Cocks, No. 14, October 1910. We have Cocks' numbers 1 and 2 Vinton, April 3, 1912, flowers only. Can you complete these?

The specimen we collected on the Gentilly Road below New Orleans April 15, 1915, seems to be *Prunus americana*, the only specimen of this species which I have seen from Louisiana. This should be followed up and mature leaves and fruit collected.

Does not *Prunus caroliniana* grow in western Louisiana? It does in eastern Louisiana and is very common indeed in eastern Texas. We have nothing here, however, to show that it grows in western Louisiana. Our only specimen from Louisiana is from West Feliciana. I should suppose that it would grow in the neighborhood of Hammond and in other places nearer the coast. I should like to know about this.

Cocks's No. 7, Sardis, received July 19, 1913, with large slightly pubescent leaves which might be those of *P. americana*, and small globose fruit. If this fruit and leaves belong to the same plant I do not know it. Can you do anything about this?

No. 9, Sardis, July 1913. I have placed this with *P. lanata.* Harbison's No. 101, Selma, September 20, 1919, is the same. I enclose a leaf of your No. 9. Your No. 9 and Harbison's No. 101 are the only specimens of this species from Alabama which I have seen and they probably represent its most eastern range. I hope you will investigate your No. 9 further and get more material. I should like to know if it is common in the region.

246

August 7, 1920.

I find in the Gray Herbarium a specimen of *Prunus caroliniana* collected by Drummond in New Orleans which of course may mean Covington. There is also a Hale's specimen in the Gray Herbarium without locality, and a specimen from Ocean Springs, Mississippi, collected by Tracy.

247

September 7, 1920.

Dr. Robert Ridgway, the distinguished ornithologist, has established a sort of bird haven on a piece of land with a area of eighteen acres near Olney, Illinois. He claims that there are sixty-four native trees growing on these eighteen acres. This of course is a very large number, but I should not be surprised if there were even more species growing, perhaps not on eighteen acres but within a radius of eight or ten miles of Selma. Can you make out a list of the Selma trees? It would be interesting to publish this in connection with Dr. Ridgway's list.

If you are in North Carolina I am sure you are enjoying yourself there. As I do not know your address I am sending this to New Orleans in the hope that it will reach you sooner or later.

248

Sept. 27, 1920.

I find no specimen of *Zanthoxylum clava-herculis* from eastern Louisiana in this herbarium. I suppose it grows there and that you have a specimen for us.

249

November 2, 1920.

There are two or three very fine Formosa conifers which we can send to you if you can find some one in New Orleans to take care of them. As they grow at a considerable altitude in Formosa there is a chance that they may prove hardy in Louisiana. Among them will be the *Taiwania* which is one of the great trees of the world. We can send you a few young plants of the Ogechee Lime, *Nyssa Ogechee*, which I do not suppose any one has cultivated before. It is worth growing for the beauty of the fruit. Also a Formosa oak.

I do not know what sort of a permit will be needed in order to send these plants into Louisiana. If one is needed will you get it from the proper authorities and send it to me? As these are all tender plants they ought to be started from here before it gets too cold.

250

November 4, 1920.

Do you remember the Persimmon trees which we saw on the Moon Plantation in Richland Parish? Some of the trees were growing in water and others on dry land. These trees had broad often cordate leaves very pubescent on the lower surface. You sent fruit of these but we foolishly allowed it to dry instead of putting it in formalin and it is not possible now to form an idea of the shape. Do you remember if it was broader than high and flattened at the ends? We have a specimen of Persimmon collected by you in swamps near New Orleans with cordate leaves pubescent below. Would it be possible to get some fruits from a tree growing in the New Orleans swamps? I am anxious to see the size and shape of the swamp Persimmon which seems to me to represent a pretty distinct variety of *Diospyros virginiana*. It is possible that the fruit is still on the trees; if not, it is perhaps on the ground underneath them. I find, with the exception of this from New Orleans, we have no Persimmon specimen from eastern Louisiana.

251

November 10, 1920.

We have no specimen of *Euonymus atropurpureus* from Alabama or Louisiana. I should suspect, however, that it would grow in Dallas County,

Alabama, as everything else seems to grow there and I should also expect it in western Louisiana as it is in eastern Texas and southern Arkansas. I shall be glad of any light you can give me on this.

252

November 16, 1920.

I enclose a list of plants which are going to you by parcel post. The *Chamaecyparis* is an immense tree in Formosa and I hope it may prove hardy in Louisiana. The *Cunninghamia* is a new species from Formosa for which the Louisiana climate may be too cold. *Juniperus taxifolia* is a very fine Juniper from the Bonin Islands which has not before been cultivated. The *Quercus* is an evergreen species from Formosa. The *Picea* and *Pinus* are also Formosa plants.

The *Taiwanias* are the most interesting trees in this collection and I hope they will succeed in Louisiana. Will you send one of them to our friends at Avery Island?

You had best keep for your own garden the *Torreya* which is the Florida species and certainly ought to do well with you, and the *Gordonia*. *Nyssa Ogechee* is a very handsome tree which I do not think has ever been cultivated before and which I should think would succeed in any part of Louisiana. We have several more plants of this to dispose of and if you would like to have them and will send us another permit you shall have them.

I am delighted to hear that you are going to have a garden at Bay St. Louis and I think we shall be able to send you from time to time many plants for it.

253

November 26, 1920.

In this herbarium there is no Louisiana specimen of *Acer saccharinum* although some of the books say that it grows in Louisiana. It does not seem to be very rare in south central Mississippi and there would not seem to be any reason why it should not occur in eastern Louisiana. As it grows in southern Arkansas it would not surprise me to hear that it grows all over the state. We certainly should have specimens of it. According to Mohr it grows all over Alabama but we have no Alabama specimen, not even from Sardis! Help needed.

254

December 27, 1920.

I am much obliged for the specimen of the Silver Maple from the neighborhood of Alexandria. This is the only evidence I have that this tree occurs in Louisiana. I am surprised to hear that your [alleged] *Xanthoxylum* grows all over Louisiana as your specimen is a *Sorbus americana* which I had not supposed was found nearer Louisiana than the high mountains of North Carolina.

If you are in North Carolina I am sure you are enjoying yourself there. As I do not know your address I am sending this to New Orleans in the hope that it will reach you sooner or later.

248

Sept. 27, 1920.

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250

November 4, 1920.

Do you remember the Persimmon trees which we saw on the Moon Plantation in Richland Parish? Some of the trees were growing in water and others on dry land. These trees had broad often cordate leaves very pubescent on the lower surface. You sent fruit of these but we foolishly allowed it to dry instead of putting it in formalin and it is not possible now to form an idea of the shape. Do you remember if it was broader than high and flattened at the ends? We have a specimen of Persimmon collected by you in swamps near New Orleans with cordate leaves pubescent below. Would it be possible to get some fruits from a tree growing in the New Orleans swamps? I am anxious to see the size and shape of the swamp Persimmon which seems to me to represent a pretty distinct variety of *Diospyros virginiana*. It is possible that the fruit is still on the trees; if not, it is perhaps on the ground underneath them. I find, with the exception of this from New Orleans, we have no Persimmon specimen from eastern Louisiana.

251

November 10, 1920.

We have no specimen of *Euonymus atropurpureus* from Alabama or Louisiana. I should suspect, however, that it would grow in Dallas County,

Alabama, as everything else seems to grow there and I should also expect it in western Louisiana as it is in eastern Texas and southern Arkansas. I shall be glad of any light you can give me on this.

252

November 16, 1920.

I enclose a list of plants which are going to you by parcel post. The *Chamaecyparis* is an immense tree in Formosa and I hope it may prove hardy in Louisiana. The *Cunninghamia* is a new species from Formosa for which the Louisiana climate may be too cold. *Juniperus taxifolia* is a very fine Juniper from the Bonin Islands which has not before been cultivated. The *Quercus* is an evergreen species from Formosa. The *Picea* and *Pinus* are also Formosa plants.

The *Taiwanias* are the most interesting trees in this collection and I hope they will succeed in Louisiana. Will you send one of them to our friends at Avery Island?

You had best keep for your own garden the *Torreya* which is the Florida species and certainly ought to do well with you, and the *Gordonia*. *Nyssa Ogechee* is a very handsome tree which I do not think has ever been cultivated before and which I should think would succeed in any part of Louisiana. We have several more plants of this to dispose of and if you would like to have them and will send us another permit you shall have them.

I am delighted to hear that you are going to have a garden at Bay St. Louis and I think we shall be able to send you from time to time many plants for it.

253

November 26, 1920.

In this herbarium there is no Louisiana specimen of *Acer saccharinum* although some of the books say that it grows in Louisiana. It does not seem to be very rare in south central Mississippi and there would not seem to be any reason why it should not occur in eastern Louisiana. As it grows in southern Arkansas it would not surprise me to hear that it grows all over the state. We certainly should have specimens of it. According to Mohr it grows all over Alabama but we have no Alabama specimen, not even from Sardis! Help needed.

254

December 27, 1920.

I am much obliged for the specimen of the Silver Maple from the neighborhood of Alexandria. This is the only evidence I have that this tree occurs in Louisiana. I am surprised to hear that your [alleged] *Xanthoxylum* grows all over Louisiana as your specimen is a *Sorbus americana* which I had not supposed was found nearer Louisiana than the high mountains of North Carolina.

Did you know that Drummond found what we now call *Rhododendron serrulatum* in Louisiana? One of his specimens in the Gray Herbarium is labeled New Orleans. In Hooker's list of Drummond's Louisiana plants Covington is given as the station. This you know is the plant you found near Pearl River, and this is the only station we know for it in Louisiana unless you have found it in Covington or its vicinity. It might well be found in swamps anywhere in the coast region of eastern Louisiana. This and *Rhododendron canescens* are the only species we know in Louisiana. It would not surprise me, however, if you should find *Rhododendron oblongifolium* somewhere in the neighborhood of the Sabine River. This species is not rare in southern Arkansas and grows near Marshall and Houston in eastern Texas. I should think it would be worth looking for as another addition to the Louisiana flora.

With all good wishes for the New Year, I am,

255

February 1, 1921.

Ulmus americana flowered in Vermont April 19th, in Massachusetts, April 15–20. From Ohio, Florida and Arkansas there is no flowering specimen in this herbarium.

Salix nigra: Massachusetts, May 20–26; Ohio, May 8; Arkansas, April 8–22; Florida, March 24. No flowering specimen here from Vermont.

Acer rubrum: Vermont, April 23; Massachusetts, April 8–21; Ohio, March 27; Florida, only one specimen in flower here collected by Chapman and not dated; Arkansas, no flowering specimen.

This is in reply to your note of January 3rd. I do not know why you have asked for this information unless it was to expose the weakness of this herbarium.

There isn't much more, I fancy, for us to find out about Louisiana trees, so why don't you prepare a list of them with short notes on their distribution and habitat and we will publish it in the Arboretum Journal if it is not too long? This will make a good start on your catalogue of Louisiana plants.

256

February 4, 1921.

In this herbarium there is only one specimen of *Bumelia lycioides* and that was collected by you at Wakefield in West Feliciana Parish where you say on the label it is common. Do you know it from other parts of the state? I should expect it at Lake Charles and in other parts of West Louisiana as it gets into the coast region of eastern Texas.

I shall be obliged for any further light you can send me on this subject.

257

February 15, 1921.

Thanks for the information about the *Bumelias*. I am glad to hear that you will undertake the catalogue. I think it would be a good idea to put

in the time of flowering for the outside world does not know very much about the behavior of trees in Louisiana. I think there should be information of the frequency of the different species in different parts of the state and their places of growth. I suppose you have all the information.

In this herbarium there is no *Halesia* from Louisiana but *diptera*. Have you ever found anything else from within the state? *Carolina* appears to be common at Selma but there is nothing here from further west.

258

February 24, 1921.

Your *Ligustrum* is *lucidum* as you suppose. Sometime ago I wrote you that I thought a specimen of *Fraxinus* collected at New Orleans by Fendler in 1846 might be *F. pauciflora*. I now feel convinced, however, that it is *F. americana*. The handsomest trees of *Fraxinus americana* I have ever seen are those below Lake Charles along the river, the trees with slender pendulous branches and narrow leaves. We collected it in early spring. Have you ever collected fruit or mature leaves from these trees? They ought to be distinguished as a variety perhaps but I do not like to do it without better material. If you have never obtained fruit or mature leaves you ought to try and get them sometime in the future. This is certainly one of the handsomest of the Louisiana trees.

259

March 3, 1921.

If there were any specimens of *Viburnums* in the package with the *Ligustrum* they were overlooked in the unpacking. If you send others we shall hope to be more careful.

It looks like an early spring here but cold weather is predicted again and New England springs are not to be relied on.

260

March 14, 1921.

Of *Cephalanthus occidentalis* we have two Louisiana specimens in this herbarium, one collected by Palmer near Natchitoches and another in the neighborhood of Lake Charles by some collector I do not know. These are both the pubescent form, the var. *pubescens* of Rafinesque. We have no specimen here collected by you, and nothing whatever from east Louisiana where I suppose it is common; nor have we any specimen from the Selma region where I should be surprised if it were not common. I should be glad of more Louisiana material.

261

March 21, 1921.

Your *Viburnum* is, as you thought, *odoratissimum*. The Blackberry is *Rubus rosaefolius* var. *coronarius*, the double-flowered form of the widely distributed Asiatic species. I am glad to know that this double-flowered

form is in cultivation in the United States and I wish you would dry flowering specimens for this herbarium where there is nothing to show that it is cultivated in this country.

The thermometer was up to 78 yesterday which means there will be a lot of damage done by frosts which are sure to come in the course of a week or two.

262

March 28, 1921.

I like your catalogue very much and am glad to get it. I see you include among the trees *Ilex lucida, Rhus glabra* and *Sambucus canadensis* which are not in the new Manual, probably by mistake. You omit *Aesculus Pavia* which certainly grows in east Louisiana where we saw the best specimen I have ever seen. *Vaccinium arboreum* var. *glaucescens* which grows about Shreveport is also omitted. I do not think there is any *Viburnum prunifolium* in Louisiana where *Viburnum rufidulum*, not in your catalogue, is common.

I am inclined to refer to *Acer saccharum* var. *glaucescens* your St. Francisville specimen 2520, May 15, 1915, my Des[s]ert Plantation, April 12, 1916, your Catalpa specimen 3170, April 15, 1919, and Palmer's Natchitoches specimen 7400, April 27, 1915. *Acer saccharum* var. *glaucescens* sometimes looks too much like *Acer floridanum*. Indeed all the Sugar Maples run together, and if there were not so many distinct varieties and forms it would be wise to consider them all as belonging to one species, but this would be very cumbersome in a book and hard to use.

I should like to know the exact range of *Avicennia* in Louisiana. We have no specimens from the state and should be glad to have them. I had supposed it was on some of the islands and not on the mainland. There is time to make corrections in this for the Manual.

A few of your names are not the ones we now use. I suppose you won't object to having your list similar to the Manual in this respect. Unless you object I will make the corrections and additions, and have the article set up and submit the proof to you.

We are having a very early season here and many things are blooming at least three weeks ahead of time. The severe frost which we are likely to get in April will do a greal deal of harm I fear.

263

April 4, 1921.

Your *Ligustrum* seems exactly like the one we gathered early one morning on the campus at the University at Baton Rouge. At the time that specimen was referred to *L. coriaceum*, but the leaves are too thin and it seems best to consider that plant and yours received today *L. japonicum* in spite of the fact that the leaves of *japonicum* are more inclined to be acute.

I notice in your list of Louisiana trees you do not say anything about

Sapindus Drummondii from Tangipahoa, your No. 71 collected in June 1900. It is certainly that species and interesting as the only evidence we have here that *Sapindus Drummondii* grows east of the Mississippi River.

In the description of *Bumelia lanuginosa* I have adopted your statement that on the Louisiana seacoast, near the mouth of the Calcasieu River, it grows on the sandy beach as a shrub, forming dense thickets in a position where it is often covered by ocean spray. We have no specimen from this coast but I suppose there is no doubt of the species. We should like a specimen from there if you can spare it. Let me know at once if for any reason the statement should be eliminated from the Manual.

264

April 18, 1921.

I have been over your list of trees and sent it to the printer. You can expect a proof in the course of a couple of weeks or so.

You speak of *Malus coronaria* in East Louisiana. This of course is *Malus angustifolia* which also occurs in a rather pubescent form near Winnfield.

You speak of *Aesculus Pavia* as growing over the state. Is not this a mistake? My opinion is that it is confined to east Louisiana and that it nowhere crosses the Mississippi River. West of the river, so far as our collections here show, the red-flowered *Aesculus* is all *discolor* var. *mollis*.

You speak of *Oxydendrum* as growing in rolling woods over the state. Is not this a mistake? We have nothing to show here that it is in Louisiana outside of West Feliciana Parish where I think, like *Magnolia Fraseri*, it must find its southwestern home. If I am wrong about this and it does occur west of the Mississippi River please let me know by return mail as there is still time to make the correction in the Manual.

Is it possible that the Osage Orange may grow naturally in the extreme northwestern corner of the state. Have you ever fully investigated that region? Elsewhere in the state I feel sure that it must be naturalized.

265

August 7, 1921.

We have included your Washington Parish *Myrica* in the list of trees, for although there is no fruit it is evidently *Myrica inodora*. Although it grows as a shrub in Louisiana it is sometimes a small tree, and therefore properly finds a place in this list. It would be interesting to find other stations and obtain if possible fruiting specimens.

By all means let us publish the list of Louisiana shrubs and the sooner you get to work the better. I fancy it will be a harder task than the trees but it can be accomplished I think.

I haven't the slightest idea what "auto-intoxication" means. It does not sound like the right kind however. What you need is a change of air and scene, and why you don't come up here and pass a month or two with me this autumn I cannot imagine. The sea voyage would do you a lot of good and you would have the opportunity to work here on your Flora.

If you are in North Carolina I am sure you are enjoying yourself there. As I do not know your address I am sending this to New Orleans in the hope that it will reach you sooner or later.

248

Sept. 27, 1920.

I find no specimen of *Zanthoxylum clava-herculis* from eastern Louisiana in this herbarium. I suppose it grows there and that you have a specimen for us.

249

November 2, 1920.

There are two or three very fine Formosa conifers which we can send to you if you can find some one in New Orleans to take care of them. As they grow at a considerable altitude in Formosa there is a chance that they may prove hardy in Louisiana. Among them will be the *Taiwania* which is one of the great trees of the world. We can send you a few young plants of the Ogechee Lime, *Nyssa Ogechee*, which I do not suppose any one has cultivated before. It is worth growing for the beauty of the fruit. Also a Formosa oak.

I do not know what sort of a permit will be needed in order to send these plants into Louisiana. If one is needed will you get it from the proper authorities and send it to me? As these are all tender plants they ought to be started from here before it gets too cold.

250

November 4, 1920.

Do you remember the Persimmon trees which we saw on the Moon Plantation in Richland Parish? Some of the trees were growing in water and others on dry land. These trees had broad often cordate leaves very pubescent on the lower surface. You sent fruit of these but we foolishly allowed it to dry instead of putting it in formalin and it is not possible now to form an idea of the shape. Do you remember if it was broader than high and flattened at the ends? We have a specimen of Persimmon collected by you in swamps near New Orleans with cordate leaves pubescent below. Would it be possible to get some fruits from a tree growing in the New Orleans swamps? I am anxious to see the size and shape of the swamp Persimmon which seems to me to represent a pretty distinct variety of *Diospyros virginiana*. It is possible that the fruit is still on the trees; if not, it is perhaps on the ground underneath them. I find, with the exception of this from New Orleans, we have no Persimmon specimen from eastern Louisiana.

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266

August 19, 1921.

Palmer is here and he and I have been carefully over your unplaced *Crataegus* material with the following results.

Palmer, Natchitoches, 9454, 8894, 8899, 7289, 7226 = *C. velutina.*

Crataegus species, low woods, West Lake Charles, C. S. S., March 23, 1917, = *C. pyracanthoides,* only known before from Mariana, Florida. I hope you will get fruit of this this autumn.

Bush, Minden, August 10, 1901, C. S. S., April 10, 1901, is *C. algens.* This is your No. 1008 of 1916.

Cocks, Crowley, 3326, 3327, April 14, 1920, *C. berberifolia.*

Natchitoches, Cocks, No. 20, April and September 1914, *C.Cocksii.*

Cocks, Crowley, 3331, *C. viridis.*

Cocks, Crowley, 3324, 3337, 3329, 3328, 3330, 3325, and Natchitoches 39, xii., xiii., xvi., is *C. edura.*

Palmer, Natchitoches, 7290 and 8722 seem to agree with *C. torva* which you have at Sardis.

This only leaves undetermined Bogulusa 3149, probably a new species of *Intricatae* and interesting as the only representative of that group from Louisiana. Fruit of this is needed. Can you get it this autumn?

Crus-galli species, Cocks, Pineville, xix., April 24, — Fruit of this is needed.

Pineville, *Crus-galli* species, April 5, 1912. Color of the anthers and fruit needed.

Viridis species with rose-colored anthers. A large tree in yard below Lake Charles collected by you and me April 21, 1907. Fruiting specimens with terminal shoots are needed.

Can't you clean these up as far as possible this autumn? Certainly there are now fewer undetermined species and specimens of *Crataegus* in Louisiana than in any other state. Of course there may be other species in the state which you haven't found yet but I do not believe there are many of them.

The proof of your article hasn't turned up yet, which is perhaps fortunate as the delay will enable me to insert these newly determined species in your list.

I hope you are well and getting through the summer comfortably.

267

August 25, 1921.

We have been looking over some of the Selma material and find a specimen of *Crataegus interior* Beadle, Harbison's No. 3, "along road to Professor Cocks's place, April 19, 1915."

Cocks 3242, Sardis, new species of *Bracteatae.* This is a very distinct and interesting looking plant in a small group with only two described species. I hope you can get fruit so that it can be named. To me this seems to be the most interesting of the Sardis species.

Cocks 827, April 11, 1912, probably *C. alabamensis*, but fruit is needed to make sure.

Harbison, Selma 2, April 19, 1915, and 58, April 12, 1917, are also probably *C. alabamensis* but we have no fruit.

Harbison, Sardis 1468, April 23, 1914, seems to be *C. ignava* but fruit is needed.

Cocks 831 and 834 may be *C. lacrimata* Small, but fruit is needed. As I have seen this species in Florida the branches are very pendulous. Is it so with your numbers?

268

August 30, 1921.

Your *Rosa humilis*, Natchitoches, July and October, 1913, and Palmer, Creston, 9428, April 18, 1918, with pubescent leaves is now called *R. Lyonii* Pursh. This species, if it is one, is widely distributed from Massachusetts to Missouri and Louisiana.

I wish this autumn you would send me for planting about a pint each of the nuts of *Carya leiodermis* and of *C. leiodermis* var. *callicoma*. As *Carya myristiciformis* seems to be hardy there is no reason why this other southern species might not be, and unless you get the nuts I do not suppose there is any one else now who could find the trees.

269

October 6, 1921

You have at last got page proofs of your acct of trees & I hope that it will now soon be published.

I have added Avery Island as a station for the Dahoon (*Ilex cassine*). We saw it by the lake with ripe fruit. I evidently failed to take a specimen & I suppose that you did as you do not mention it.

We have no La. specimen of this species in this herb. Can you let us have one.

I hope that you are all right again.

How about the shrubs? We are ready for them.

270

October 28, 1921.

I do not see any objection to your including in your list of shrubs those which are occasionally trees and which have appeared in the previous list. I suppose you will let us have a specimen of *Ilex* and *Amelanchier*.

Sorry to hear the Crataeguses have been behaving so badly this year. It certainly takes time and patience to get these things.

271

November 28, 1921.

I have at last found time to look over your last sending of specimens.

5001 can only be *Fraxinus americana* with unusually large fruit and with an obtuse wing.

5003 is *Viburnum scabrellum.*

5004 is *Ilex longipes* of Chapman. You collected the same thing in flower in the same locality and in several other places in the state where it appears to be common east of the Mississippi.

Ilex amelanchier is a good find for Louisiana. It is not very rare in Alabama but I have seen no specimen in Mississippi.

272

December 5, 1921.

Your list of Louisiana trees is in the April number of the Journal of the Arboretum which, owing to a printers' strike, has not yet appeared, although we have seen it in page-proof. This strike is very annoying. It has entirely demoralized the issues of the Journal, but the Manual is now promised for the middle of January.

Fraxinus Darlingtonii and *Fraxinus Smallii* exist only in the fertile brain of Dr. Britton.

With the compliments of the season,

273

December 13, 1921.

Palmer's *Rubus* 7431 is referred in the Flora of North America, which is published by the New York Botanic Garden, to *carpinifolius* Rydberg. The type of this species was collected near Alexandria. Palmer's 7208 is in the same work called *R. floridus* Rydberg. How good these species are you can judge as well as I can.

There are a number of distinct forms of *Rhus toxicodendron* in your part of the world and it was one of these which we collected at Shreveport. Nothing has ever been done in the way of separating this species into varieties but it certainly ought to be done. We have a large collection of them in the herbarium here.

The proper name of the *Ptelea* which we collected at Lake Charles is *P. trifoliata* variety *mollis* Torrey & Gray.

It seems a hard proposition to try and get any of Palmer's specimens from St. Louis for you. Palmer has talked about it several times and I have written. Palmer, who is working here this winter, will be in St. Louis in March and in half a day could pick out a set of herbaceous plants for you if he was permitted to do so. I do not know if this could be managed but it will do no harm to try. You certainly ought to have the plants and we made a mistake not to have asked Palmer to collect a special set for you and send them direct. I understand you have all the numbers of Palmer's woody plants.

With the compliments of the season, I am,

274

December 28, 1921.

Palmer's 9428 is a Rose. His *Vaccinium tenellum* number is 9429.

This number and his 9411 and 9469 we think are *Vaccinium vegetum*. We have no *V. corymbosum* from Louisiana, although it is said to grow there by Small. He also credits *V. fuscatum*, which is *V. corymbosum* var. *fuscatum* Gray, to Louisiana. We have one specimen of this from Texas. It only varies from *corymbosum* by the pubescent under surface of the leaves and by the pubescent branchlets. This variety grows in southern Georgia, and as it grows in Texas it might be expected in Louisiana, although we have no specimen from either Alabama or Mississippi. From Louisiana we have only one specimen of *V. tenellum*, your 4333 from Bayou Lacombe. We have no specimen of *Vaccinium myrsinites* from Louisiana.

It looks as if there was still a great deal of *Vaccinium* work to do in your state.

With all good wishes for the New Year,

275

January 11, 1922.

I have your package of *Vacciniums*.

3343, Fulton ?, is apparently *V. corymbosum*. All the others, Benton 3210 and 3207, Covington 1504, and Natchitoches 3202 are *V. virgatum* according to our understanding of that species.

I am glad to hear you are moving to Bay St. Louis which I am sure you will enjoy much more than New Orleans, and that you will have the opportunity for a good garden. In the spring we can contribute to it, if you say so, some Azalea and Camellia plants and possibly a few other things.

276

January 13, 1922.

Your *Crataegus* 966 and 3342 of September 19, 1915, and April 20, 1916, has twenty stamens. This seems a distinct and handsome new species of the *Bracteatae* group of which only two species have been described. The color of the anthers is not given. Can you get notes on them this spring or, if that is not possible, can you tell Harbison where this tree is growing? This is certainly your best *Crataegus* discovery and I am sorry *Crataegus Cocksii* is preoccupied. Will you suggest a name for it?

No. 7, Harbison, April 20, 1915, from the Sumner region we are referring to *C. blanda*.

Your Jasmine is the double-flowered form of *J[asminum] Sambac*.[23] This plant is widely cultivated in warm countries but I have not before seen specimens from the United States except from San Diego, California. It is of doubtful origin as to country and I think only the double-flowered form is known.

[23] Jasmines have long been favorites in French gardens; Nicholson mentions them for Santo Domingo in 1776 and Lelievrie, for New Orleans in 1838, but without specific names.

277

January 23, 1922.

Glad to hear about the color of the anthers of 3342. We have, I think abundant material of this with the exception of seeds which should be collected for planting. I hope you will invent a good name for it. Better send us a specimen of the plant which you have been calling *Jasminum Sambac* and perhaps we can help you. Certainly what you sent before is the *Sambac*.

My variety of *Quercus coccinea* with thickened cup-scales was based on plants from your place in Alabama. This was stated in my paper on *Quercus* in The Botanical Gazette, and if it were not easy to make mistakes I should be at a loss to understand why this fact was not brought out in the Manual.

So far as I have observed all the Scarlet Oaks in the Selma region which I saw had these thickened cup-scales.

Another mistake which has been pointed out to me is that Small and not Ashe is the authority for *Tilia floridana*, and I am feeling rather disgusted.

278

February 6, 1922.

I am describing Palmer's *Crataegus* 7234 and 8843, April and October 1915, from Natchitoches as *C. erioclada* and his 3719, September 1915, as *C. brachyacantha* forma *leioclada*.

The copy of the Journal with the Louisiana list of trees has arrived here this morning and I hope you will soon get your extras of the article. When you do I wish you would let us have one so that we can have it in this library as a separate.

279

February 17, 1922.

Crataegus erioclada is a new species, a description of which will appear in the next number of the Journal I hope.

I have no doubt there is a lot of collecting to be done along the Mississippi coast. I am glad to hear you are to undertake it.

280

March 1, 1922.

The omission of *Q[uercus] virginiana* might have got by you but I cannot imagine how it got by us here where the article and proof was certainly read times enough to prevent any such glaring omission. I think the best plan would be to add a note to your list of Louisiana shrubs making the correction. It would be more apt to be noticed there than if put by itself in the Journal.

How is the list of shrubs getting on[?]

281

April 21, 1922.

We were getting ready to send you next week the *Camellias* and other plants for your new garden when we discovered that it was necessary to get a permit from the Horticultural Inspector of Mississippi, and I am writing him today for one. This means I suppose that the sending of the plants will be delayed for at least a couple of weeks. It won't do any harm if you wrote to the Inspector yourself on the subject in the hope of hurrying him up.

You haven't suggested yet the name for that fine and very distinct *Crataegus* of yours from Selma.

We have a late spring here this year and last night had rather a heavy frost, but on the whole the Arboretum looks fairly well.

282

May 9, 1922.

I have now the permit from Mississippi to send you the plants for your garden and they shall go forward in the course of a day or two.

There is no specimen of *Calycanthus* in this herbarium from Louisiana or Mississippi and I did not know it extended as far westward. By all means send me all the material you can of your two species for this is now one of the genera we are especially interested in as there seems to be great confusion in the cultivated plants. For example, *Calycanthus floridus* which is supposed to be in every garden we cannot find cultivated anywhere in this country except in the Berckmans Nursery in Georgia where the yellow-flowered form is growing. In Alabama we know *Calycanthus floridus* only from Spring Hill near Mobile, Lookout Mountain, near Gadsden, and at Barclay. I am surprised it does not grow at Selma. Perhaps you will find it there.

How are you getting on with the catalogue of shrubs and aren't you coming up this summer to work here on your general catalogue? You certainly never can complete it without passing some time at the north, and what is the use of delaying your coming any longer?

283

May 23, 1922.

Your two specimens of *Calycanthus* seem to be the same, although the specimen from Bay St. Louis has remarkably narrow sepals. They appear to be forms of *fertilis nanus* and if this determination is correct it is remarkable to find them on the Gulf coast, for *fertilis nanus* has previously been known only from the mountains of North Carolina. I should have expected that you would have found in your region *C. floridus* which grows in the neighborhood of Mobile and is a southern species.

You ought to look further for *Calycanthus* for it is possible that you have other forms or species. It would be well to get fruiting specimens of the two plants of which you have sent the flowers.

I noticed that Small does not credit any *Calycanthus* to either Mississippi or Louisiana.

284

May 26, 1922.

I am interested in what you say about *Calycanthus floridus* in Louisiana and I hope we shall get a specimen of it from the state. I shall be glad, too, of one from the Selma region. There are two forms of *floridus*, one with much broader leaves than the other, and I am anxious to know which is the form which grows in Louisiana.

We have at last dispatched your plants to Bay St. Louis and I enclose a list of them. *Rhododendron Chapmanii* is not a plant with very showy flowers, but it is an interesting species found only close to the Gulf coast of west Florida. We had a many years' hunt for this plant which was originally discovered by Chapman and described by Gray. It should grow perfectly at Bay St. Louis.

I hope the *Juniperus taxifolia* will grow. It is a native of the Loochoo Islands and has not before been cultivated. There is a good chance, however, that it will prove hardy in Bay St. Louis.

There isn't much to say about the other plants which are going to you.

285

June 28, 1922.

We have received the list of Louisiana shrubs. *Act[a]ea alba* is no doubt included by mistake as it is certainly an herbaceous plant.

I still think *Rhododendron* (*Azalea*) *oblongifolium* must grow somewhere in western Louisiana as it is so common in Arkansas, eastern Oklahoma and eastern Texas. Don't you think you should look further for it in the valley of the Sabine River?

It seems to us very doubtful if *Philadelphus grandiflorus* grows naturally in Louisiana and I think your best plan would be to send us a specimen now of the plant which you say is often cultivated and sometimes naturalized in the state. No matter if the plants are out of flower if you haven't a spare specimen. Flowering sp[ecimen].

It is certainly very surprising that there is only one species of *Ribes* in the state. Does not *Daubentonia* die down to the ground every year? I had supposed it was herbaceous.

On the whole I am rather disappointed in the number of shrubs in Louisiana. Proportionately it is not as great as the number of trees. It would be surprising, however, if you or any one else have found them all.

286

July 1, 1922.

We have now examined critically your list of shrubs. I have already written you about *Philadelphus grandiflorus*. Rydberg gives Rapides Parish for *Rubus carpinifolius*.

Rosa Treleasei Rydberg. This species grows at Baldwin Bridge, Bossier Parish. The specimen is in the herbarium at St. Louis.

According to Rydberg *Amorpha tennesseensis* should be added to the list. You omitted entirely the *Rutaceae*, and *Acacia angustissima* collected by Palmer at Natchitoches. In the list *Cornus stricta* appears twice. One of these we think must be *C. asperifolia* as we have many specimens of that species from Louisiana where it appears to be generally distributed.

Azalea we now make a section of *Rhododendron*. What you call *Viburnum pubescens* is the large-leaved form of *V. scabrellum*.

The Vines, of which there are several species and genera, are omitted from this list. Don't you think they should be included as they are always considered to be shrubs? Will you supply us with a list of these and we will incorporate it?

287

August 8, 1922.

I hear for the first time from you of *Pinus Sondereggeri*. I feel very skeptical about its being a hybrid. Who named and published the tree? [24] If it is possible to obtain this information and for us to see specimens at once there will probably be time to get some mention of the tree in your shrub paper which has now been in the hands of the printer for about two weeks. There would not, however, be any time to lose in getting the information. The fact that there appear to be a great many of these trees would tend to show that it was not a hybrid. *Pinus palustris* flowers so much earlier than *Pinus taeda* that it would be difficult for these species to hybridize. We should certainly see specimens.

It would surprise us here very much if *Cornus amomum* was found in Louisiana. We certainly have no specimen in the herbarium of this northern plant from Louisiana and if you have one I wish you would let us see it. For the time being at least we have omitted *Cornus amomum* from your list.

Gleditsia texana will have to be included among the Louisiana trees. I consider this now to be a hybrid [25] and have referred to it the tree from Shreveport, Louisiana, from which I have collected specimens. Nuttall appears to have found it more than a hundred years ago near the mouth of the Arkansas River and we have a specimen which you sent from the Yazoo River, Mississippi, and one from southwestern Illinois.

If there is anything more to say about your paper it is not too late to do it. The proof of course will be sent to you as soon as we get it. The printer, however, is as usual very slow.

288

August 22, 1922.

We have submitted your mysterious Pine to Shaw who has made a critical examination of it and finds no trace of *Pinus palustris*, either in

[24] CHAPMAN, H. H. Jour. Forestry 20: 734. *pl. 1*. 1922.
[25] Cf. Jour. Arnold Arb. 3: 182, 206–207. 1922.

the cone or in the internal structure of the leaf. He pronounces it *Pinus taeda* and I feel sure that he is right. Of course we ought to know if possible if such a thing has ever been published, where and by whom. If the name is published it should become a synonym of *Pinus taeda*.

The principal things I want from you now are a few fruiting specimens of *Crataegus*, especially Sardis 3342, collected by you in flower April 12, 1919. This is the new species in the *Bracteatae* Group and I am particularly interested in it as only two other species are known. I am also anxious for fruit of the *Viridis* species with twenty rose-colored anthers growing in the yard of the house on the left hand side of the road along the river below Lake Charles. You remember the tree I am sure and how handsome it was. This also is possibly undescribed.

We have from you two *Crus-galli* species from Pineville, one collected April 1912, without any number, and the other numbered XIX., April 24, no year. We ought to have fruit of these two trees. No color of the anthers unfortunately is given with the specimens. Have you got it? Fruit of Bogalusa 3149, April 9, 1919, a *Viridis* species, is also needed.

Bogalusa 3151 is a species of the *Pulcherrimae* apparently undescribed if you are sure of the color of the anthers. The flowers on our specimen are pretty much faded and the color may have changed. This is interesting as the only *Pulcherrimae* we know of in Louisiana. Do you remember anything about the size and habit of the plant and have you any other notes on the color of the anthers?

This is all the undescribed Louisiana material we have and if you have everything there is the *Crataegus* material of Louisiana is better worked up than that of any other state. You can add to the Louisiana trees *C. blanda* Sargent, Minden, Bush No. 663, August 10, 1901. This is a *Viridis* species with very dark scaly bark. I think we looked at this from trees growing near *C. aestivalis* but I do not find that I made any specimen.

I am most interested now in the Sardis 3342 and in the St. Charles *Viridis* species. I hope you will certainly be able to get them and possibly the Pineville and Bogalusa material. Of the latter it would be better to get more material of 3151.

289

November 7, 1922.

In your catalogue you mention a Catalogue of the Plants of Southern Louisiana by the Reverend Langlois. We have n't a copy of this. Can you get one for us?

Can you give a locality for *Hypericum lobocarpum* as being near Louisburg, St. Tammany Parish? We cannot find this name in the atlas and are therefore omitting it. In this herbarium there is no specimen of *Hypericum lobocarpum* from Louisiana. Can you let us have one?

I am afraid your entry of the American *Ampelopsis* is incomplete. There is no specimen of the typical plant here but specimens of two varieties. We ought to have better material of this plant in this herbarium. We have

decided to leave out any reference to the type and put in the two varieties represented in this herbarium.

It is too late to send you the page-proof as I hope the article will now be printed in a short time. We have done the best we can with it but I daresay there are still some omissions.

Can't you get for me a quart of acorns of *Quercus virginiana*? I want to send them to a correspondent in South Africa where exotic trees appear to do better than in any other part of the world. Before sending it would be best to put the acorns in water and send only those which float; those which sink will have grubs in them. It will be best to send them in a box of soil as acorns lose their germinating power very quickly.

Are you going to be able to get me the nuts of *Carya leiodermis* and its variety *callicoma* this autumn? I very much want to plant them here in the hope that the trees will prove hardy.

290

December 26, 1923.

I owe you an apology for the long delay in answering your letters of October 24th and 29th in regard to various specimens of Hickories sent at that time.

You say that No. 1 which you call *leiodermis* is the only one you recognize. No. 2 is clearly the same thing. I think these trees cannot be referred to *leiodermis*. The branchlets and leaves are much too pubescent as I understand that species. We are putting the specimens among the undetermined ones and I hope you will follow these trees up in the spring; as I understand them now they do not fit into any of the described species. Nos. 3 and 4 are *C. glabra* [var.] *megacarpa* which is a common species along the Gulf coast.

Carya ovalis [var.] *obcordata* from West Feliciana seems to me to be rightly determined. Apparently we did not know this tree from Louisiana before and it is certainly some way beyond its known range; it is a good find.

Your *Betula* from West Feliciana is a very pubescent but not uncommon form of *Betula nigra*. We shall be glad of one of your specimens of *Oxydendron* from the Natchitoches region.

I am very sorry indeed to hear that that beautiful *Crataegus* from south of Lake Charles has been cut down before we had an opportunity to describe it. You ought to be able, however, to find others in that region. I hope you are not going to give up that Selma species which is one of the most interesting of all your *Crataegus* discoveries.

Castanea alnifolia [var.] *floridana* is not that species but probably a form of *Castanea pumila*.

Here we have so far had a very mild winter with a green Christmas. Once only the thermometer has been as low as 18 and there has been no snow yet to speak of. I trust you are equally fortunate in your part of the world.

With all good wishes for the New Year, believe me,

291

February 24, 1925.

Please excuse me for the long delay in answering your letter of February 5th about tree surgery as practiced by Davey. I am a disbeliever in it.

In the first place it is very expensive, and when a cavity is filled with cement it is impossible to prevent moisture forming between the surface of the wood and the cement. This brings on decay and many trees have been destroyed in this way. Davey and his system are the produce of extreme advertising. The only way to treat a cavity in a tree is to clean out thoroughly all decayed wood and then keep the surface painted with tar, leaving the cavity open so that what is going on can be watched. Of course the tar will have to be renewed from time to time. Sometimes a very old tree is so far gone that it is better to cut it down and replace it by a young one.

I hope you are well this winter and enjoying life, and that you are preparing to come north next summer and do some serious work here on your book.

We have had a very bad winter for plants — no snow, extreme drought and some very cold weather. I am afraid there will be many losses in the Arboretum before spring really comes.

292

March 2, 1925.

Sudworth has published in last year's Journal of Forestry (our copy now unfortunately in the hands of the binder) *Carya Ashei*, distinguished by 7–9 leaflets and remarkably long stigmas. I have seen the type plant from Pensacola, Florida, the only one which has been collected apparently with pistillate flowers. One leaf of this tree has nine leaflets; all the others have only seven. I do not think it is safe to establish species on such scanty material. To me it seems to be a variety or form of *Carya ovalis*. The species, as you know, extends along the Gulf coast to southern Mississippi and Louisiana in some of its forms. I wish you would look out for such a tree this spring when the Hickories are in flower and see if you can find any of them with nine leaflets, or what is more important the exceptionally long stigmas.

I suppose it begins to be a little springlike in your part of the world. Here it is cold, dry and generally disagreeable, with a prospect of a good deal more winter before us.

With kind regards,

293

March 7, 1925.

We have all been looking again at your Hickory from Bay St. Louis. Judging from the leaves I do not think there can be any doubt that it is *Carya alba*. It is unusual in the thinner husk of the fruit and in the less pointed, strongly angled and paler nuts. The nuts of this species are

very variable, and I think we can match yours almost exactly from among Palmer's collections west of the Mississippi. I should like to know how the bark looks. Would it not be possible to get a photograph of a trunk to go with your specimens?

I am sorry to hear there are more *Crataeguses* to find but I am not surprised.

It is acting now like an early spring but I suppose we shall have a lot more snow. It is still terribly dry and during this week the thermometer has been down to 10 above zero.

294

July 1, 1925.

Your *Amelanchier* from Alabama is a common northeastern species. *A. intermedia* Spach, but it appears to have been more or less cultivated at one time in the southern states for its fruit.

There are no mosquitos yet in this part of the world and the best thing for you to do is to come up to New England and pay us a summer visit.

You do not say anything about your Louisiana Flora. Are you still working on it and, if so, how is it getting on?

I wish I heard from you oftener, and I much want to see you again but I am afraid I shall never get as far from home as Louisiana. You must come up and see me.

295

August 19, 1925.

I am not sure that I ever answered your note of June 27th in which you ask about a small shrubby *Amelanchier* in Alabama which grows you say in a few places near Selma.

The name of the species is *Amelanchier intermedia* Spach.

I fancy there are still hybrid Oaks and Hickories to find in Louisiana.

You must certainly come up and see the Arboretum sometime. There are few mosquitos here just now and on the whole this has been a wonderful summer, and the Arboretum has never before looked so well at this season.

296

September 11, 1925.

I am working over a paper to be published in the Arboretum Journal giving a list of errors which occurred in far too great numbers in the second edition of my Manual of Trees of North America, and if you have noticed any mistakes I wish you would call my attention to them. There are misspellings of geographical names and many errors in distribution; the latter are the most important, and I should especially like to know of any of these relating to Louisiana trees.

With kind regards, I am,

297

October 22, 1925.

Glad to get your note of the 18th. The separates will be sent to you soon.

I do not believe you dislike clerics more than I do but I cannot help feeling sympathy, as I wrote you, for the unfortunate old Bishop from Arkansas.

I hope you will send us a specimen of the Oak from Bay St. Louis.

We have no record here that *Raphidophyllum hystrix* grows in Alabama and of course we should be glad to get a specimen from there.

298

December 30, 1925.[26]

I am distressed at the news conveyed about your health in your note of the 17th of December. I can only hope that your views of the future are not as bad as you state. I wish there was something I could do for you or send you, and if you will only intimate something you would like, some book perhaps to read, you shall have it if I can procure it for you. I really cannot tell you how badly I feel. Of course you will be out again in the spring.

I am still fairly well and getting to the Arboretum every day but am too old to enjoy life.

As I hope you know, I am,

Always sincerely and devotedly yours,

299

January 11, 1926.

I am certainly sorry that you will not be able to meet Dr. Councilman for he is a delightful and learned man, and has a charming wife. Moreover, he has become much interested in plants, especially in the study of peculiar fungous growth on the roots of Oak-trees. I am sorry to say he has not sent me his New Orleans address but if you have it I hope you will write to him.

You have asked me about thrilling novels which is one of my specialties, and I will see in future that you are well supplied with them. I have already sent you three or four and others will follow. I shall feel that I have n't lived in vain if I have introduced you to "Nick Carter," [27] the most thrilling of all, and among the long series certainly are some of the best detective stories which have ever been read.

Let me hear occasionally if you get any pleasure from the books I send you and I hope that your health is improving.

[26] Addressed to Professor Cocks at Bay St. Louis, Mississippi, where he had moved that year.

[27] Fictional character in dime novels fathered about 1885 by J. R. Coryell (?) but publicized in any event by Street and Smith, New York, producers of over 1000 stories about him by several authors.

300

January 27, 1926.

I have n't heard a word from Councilman since he reached your part of the world, but I have heard of his visit to Natchez through Miss Compton and that he is now laid up in bed in New Orleans and obliged to postpone starting for Havana. I am afraid he has n't been able to see you which I greatly regret for he is a delightful person.

As you are a Britisher and no doubt a tea-drinker I am sharing with you some tea sent me by J. P. Morgan which has a remarkable reputation. I cannot vouch for this personally as I never drink tea. I believe it is better with lemon than with milk. If you don't like it there are probably plenty of people to whom you can give it.

I hope you are getting on better and that I shall hear from you again before long.

With kind regards,

301

March 19, 1926.

I find in our herbarium we have a *Crataegus uniflorae* species with very small flowers collected by Harbison April 19, 1911, and labeled "C. uniflora at Professor Cocks's along road in the woods." Have you ever collected any fruiting specimens of this plant and do you know anything about it? I am not quite sure what he means by your place, whether it was in Mississippi or at Sardis, Alabama, where you seem to have collected a good deal. We have a specimen collected by you there on April 2nd, 1919, in flower (No. 3342) with twenty stamens and yellow anthers. What is this? Have you a fruiting specimen? This may be undescribed. We also have complete fruiting material of a *Flavae* species (No. 968) collected in 1915 and 1916 at Sardis. Do you know anything about this?

We are trying here with much difficulty and not much success to arrange a lot of unplaced *Crataegus* material and badly need help.

I hope that you are improving and able to enjoy the spring which is now probably upon you. It is still wintry here with the ground covered with snow.

With kind regards and all good wishes,

302

November 1, 1926.

The *Crataegus* No. 4126 from Chestnut, Louisiana, appears to be without doubt *Crataegus drymophila* Sargent.

Faithfully yours,

/s/ C. S. Sargent

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BARTRAM, WILLIAM (1739–1823), son of pioneer American botanist JOHN BARTRAM, and himself an explorer-naturalist who visited Louisiana in 1775 and published his *Travels* in 1791, 7

BEADLE, CHAUNCEY DELOS (1866–), forester, son of a nurseryman of St. Catherines, Ontario, who went to Biltmore, N. C., in 1900 to manage planting operations on the estate of GEORGE W. VANDERBILT; became a student of *Crataegus*, 18, 156

BERCKMANS, PROSPER JULIUS ALPHONSO (*c.* 1830–1910), Belgian-born "Georgia horticulturist," assisted CHARLES and A. J. DOWNING in revision of their *Fruits and Fruit Trees of America*, and whose nursery "Fruitlands" near Augusta served the South, 282

BLARINGHEM ("BLARENINGHAM" of the letters), LOUIS (1878–), French botanist, geneticist, at one time member of Pasteur Institute of University of Paris, 203, 208

BOSC, LOUIS AUGUSTIN GUILLAUME (1759–1828), French naturalist who visited the Carolinas, 1798–1800, author of a treatise on oaks, 189

BRITTON, NATHANIEL LORD (1859–1934), American botanist, the "Great Britton," first director of the New York Botanical Garden, who launched its field studies of neotropical floras, 42, 175, 231, 237, 272

BUCKLEY, SAMUEL BOTSFORD (1809–1883), naturalist and collector, who travelled in Georgia and was twice State Geologist of Texas, 109

BUSH, BENJAMIN FRANKLIN (1858–1937), botanist, settled in Independence, Missouri, in 1865, and in 1893 exhibited a collection of plants of the state at the Columbian Exposition, 25, 73, 168

BUTLER, EDWARD, and wife, of Catalpa, West Feliciana Parish, hosts to many botanists at their plantation where there was once a hothouse three stories high in which pineapples ripened and many exotics flourished, 25, 168, 200

CARPENTER, WILLIAM MARBURY (1811–1848), physician, botanist, professor, taught at Centenary College, Jackson, West Feliciana Parish, and at University of Louisiana, New Orleans, for whom TORREY and GRAY named the genus *Carpenteria*, 22, 140

CHAPMAN, ALVAN WENTWORTH (1809–1899), botanist, physician, who arrived in Georgia in 1831, and finally, in 1847, settled in Apalachicola, Florida, where he practiced medicine for more than fifty years, 255

COMPTON, CHARLES CROMARTIE, of Natchez, where she was affectionately known as "Miss Charlie," and "who greatly aided the Arboretum by gathering material of the woody plants of Adams County, Mississippi" (Sargent), for whom *Quercus comptonae*, "one of the handsomest American oaks," was named, 118, 300

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Medical School from 1891, member of Hamilton Rice Amazonian Expedition to study tropical diseases, 299, 300

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DODSON, WILLIAM RUFUS (1867–), forester, author of a brochure distributed at Louisiana Purchase Exposition, St. Louis, 1903, on Louisiana forests and timber woods, 5

DRUMMOND, THOMAS (1790–1835), ardent Scottish botanical explorer in western Canada, Texas, and southeastern United States, whose exsiccatae were sold to subscribers by WILLIAM JACKSON HOOKER, 119, 169, 189, 230, 231, 246, 254

DUNCAN, STEPHEN (1787–1867), physician, who came to Natchez in 1808, became president of the Bank of Mississippi and created "Duncan's Park," 118

ELWES, HENRY JOHN (1846–1922), F. R. S., arboriculturist, Victoria medallist, educated at Eton, world traveller, author of *A Monograph of Lilium*, and with A. HENRY of *The Trees of Great Britain and Ireland*, 200, 202, 204, 205, 208, 210

FAXON, CHARLES EDWARD (1846–1918), botanist, artist, who, Sargent said, drew more analytical sketches of trees than any other botanical draughtsman; from the first drawing in 1882 he completed 744 plates for the *Silva* in just twenty-one years, 23

FENDLER, AUGUST (1813–1883), German-American botanical explorer of New Mexico (cf. ASA GRAY's *Plantae Fendlerianae Novi-Mexicanae*, 1849), Venezuela, Panama, and Trinidad, 231, 258

FERNALD, MERRITT LYNDON (1873–1950), distinguished American botanist, Fisher Professor of Natural History and Director of the Gray Herbarium, Harvard University, long editor of and contributor to *Rhodora*, author of eighth edition of *Gray's Manual of Botany*, 54

GRAY, ASA (1810–1888), Fisher Professor of Natural History at Harvard, from 1842, most prominent American botanist of the nineteenth century, author and critic, 186

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HARPER, ROLAND MCMILLAN (1878–), veteran botanist of Alabama, author of a *Phytogeographical Sketch of the Altamaha Grit Region of the Coastal Plain of Georgia* (1906), to which SARGENT referred, 39, 133

HEDRICK, ULYSSES PRENTISS (1870–1951), horticulturist, special student of fruit crops, 40

HOOKER, WILLIAM JACKSON (1785–1865), distinguished British botanist, first at Glasgow, then for 24 years director of the Royal Botanic Gardens, Kew, who described DRUMMOND's plants from America, 230

KING, GRACE ELIZABETH (1851–1932), author of *Creole Families of New Orleans*, etc., born and educated in that city, "she became a symbol of its culture, the best representative of the city's charm and hospitality." Professor Cocks gave a speech, "The Fiction of Grace King," at a memorial dinner (La. Hist. Quart. **6**: 353–359. July, 1923), 242

LAMB, WILLIAM HARRISON, forester, 42

LANGLOIS, AUGUSTE BERTHELEMY (1832–1900), botanist-priest of Point-a-la-Hache, Plaquemines Parish, and St. Martinsville, St. Martin Parish, particularly interested in fungi and mosses, and author of *Catalogue provisoire de plantes phanérogames et cryptogames de la Basse-Louisiane, États-Unis d'Amérique* (1887), 289

LEAVITT, ————————, landscape gardener, 226

LETTERMAN, GEORGE WASHINGTON (1841–1913), teacher in public schools of Allenton, Missouri, who botanized principally in that state but also in the southern states and the Rocky Mountains, and for whom SARGENT named a *Crataegus*, 140

LOVELL, PHEBE SUSAN (MRS. PRESTON SPENCER LOVELL), of Crowley, Louisiana, amateur botanist, for whom Professor EZRA BRAINERD named *Viola lovelliana*, 241

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MCILHENNY, SARAH AVERY (1860–1948), oldest sister of EDWARD AVERY MCILHENNY (1872–1949), naturalist of Avery Island, Louisiana, etc. 89, 93, 136

MOHR, CHARLES THEODORE (1824–1901), German-born botanist, who accompanied AUGUST KAPPLER to Dutch Guiana as botanical collector, lived in Cincinnati, Ohio; California (as a '49er); Indiana; St. Louis, Missouri, and in Mexico, and for more than forty years was a pharmacist at Mobile, Alabama, author of *Plant Life of Alabama*, 8, 113, 124, 133, 253

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MORGAN, HENRY GIBBES (1843–1925), president of Audubon Park Commission, New Orleans, 47

MORGAN, JOHN PIERPONT (1867–1943), New York banker, son of famous banker of the same name, 300

NASH, GEORGE VALENTINE (1864–1921), agrostologist, head gardener at New York Botanical Garden, who collected in Florida, 119

NEALE ("NEAL" of letters), HAROLD J., "general superintendent and landscape architect," Audubon Park, New Orleans, 160

NESS, HELGE (1861–1928), horticulturist, Texas Experiment Station, College Station, Texas, interested in plant hybrids, 155, 156

NUTTALL, THOMAS (1786–1859), English-American naturalist, at one time Curator of the Botanic Garden at Harvard University, who twice visited New Orleans, author of *The North American Sylva*, 16, 54

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RAFINESQUE, CONSTANTINE SAMUEL (1783–1840), eccentric naturalist, born near Constantinople of French and German parents, who taught botany and modern languages at Transylvania University, and wrote on banking, history, shells, and fishes, but especially on plants, including *Florula Ludoviciana* (1817), 64

REHDER, ALFRED (1863–1949), Associate Professor of Dendrology, Harvard University and curator of the herbarium of the Arnold Arboretum, author of *Manual of cultivated Trees and Shrubs hardy in North America*, 13, 32, 34, 140, 237, 238, 242

[RICHARDSON, IDA ANN SLOCUM (d. 1910), second wife of Dr. TOBIAS GIBSON RICHARDSON, Dean of Tulane School of Medicine, 1865–1885, both were world travellers and amateur horticulturists, 242]

RIDDELL, JOHN LEONARD (1807–1865), physician, chemist, botanist, for the last thirty years of his life a resident of New Orleans, author of *Catalogus Florae Ludovicianae*, published in the New Orleans Medical and Surgical Journal in 1852, 22, 161

RIDGWAY, ROBERT (1850–1929), distinguished American ornithologist, curator of birds in the United States National Museum for over fifty years; spent his later years at Olney, Illinois, where he preserved a tract of virgin hardwood forest, 247

ROBIN, CLAUDE CESAR (1750–), author of *Voyages dans l'interieur de la Louisiane* (Paris, 1807), which contained the first botanical resumé for the state, "Flore Louisianaise," in the third volume, published in modified English form ten years later by RAFINESQUE, 35

ROBINSON, BENJAMIN LINCOLN (1864–1935), American botanist, Asa Gray Professor of Botany at Harvard, first editor of *Rhodora*, brother of JAMES HARVEY ROBINSON, historian, 186

[SARGENT, ANDREW ROBESON (d. 1918), son of CHARLES SPRAGUE SARGENT, 169]

SCHENCK, J. S., forester who collected type of *Quercus schenckiana* Trel. in Mexico in 1898, but not to be confused with JACOB SCHNECK (1843–1906) for whom *Q. schneckii* Britt. was named, 42

SHAW, GEORGE RUSSELL (1848–1937), author of a handbook of knots and splices, and a monograph, *The Genus Pinus*, 288

SHUMARD, BENJAMIN FRANKLIN (1820–1869), competent state geologist of Texas, removed in 1860 by Gov. SAM HOUSTON, commemorated by S. B. BUCKLEY in *Quercus shumardi*, 109

[SLAUGHTER, (MRS.) MARY MARBURY, of Ruston, Louisiana, niece of W. M. CARPENTER, 22]

SMALL, JOHN KUNKEL (1869–1938), American botanist, associated with the New York Botanical Garden for a lifetime, author of *Flora of Southeastern United States* (1903) and *Manual of the Southeastern Flora* (1933), 2, 39, 46, 56, 87, 108, 140, 166, 186, 277, 283

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TRACY ("TRACEY" of the letters), SAMUEL MILLS (1847–1920), agronomist, resident of Biloxi, Mississippi, who collected in southern and western states, 17, 30, 138, 246

TRELEASE, WILLIAM (1857–1945), American botanist, director of Missouri Botanical Garden, 1889–1912, monographed *Agave*, *Quercus*, *Phoradendron*, and *Piper*, 188

WIEGAND, KARL MCKAY (1873–1942), professor of botany, Cornell University, author of a revision of *Amelanchier*, etc., 228

WILSON, ERNEST HENRY (1876–1930), English-American botanist, plant explorer in China — "Chinese Wilson" — Japan, Korea, and Formosa, author of horticultural books, assistant director of the Arnold Arboretum, 1919–1926, keeper, 1927–1930, 100, 217

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COMPARATIVE ANATOMY OF THE LEAF-BEARING CACTACEAE, XIV

PRELIMINARY OBSERVATIONS ON THE VASCULATURE OF COTYLEDONS

I. W. Bailey [1]

A consensus of anatomical evidence presented in preceding papers of this series clearly indicates that the most primitive and structurally least specialized surviving representatives of the Cactaceae occur in the genus *Pereskia*. Such better known species as *P. sacharosa* Griseb., *P. bleo* DC. and *P. grandifolia* Haw. have long been recognized by various taxonomists as having a habit of growth and absence of accentuated succulence characteristic of many typically woody dicotyledonous trees and large shrubs. These species in contrast to other representatives of the Cactaceae exhibit only slight evidence of incipient trends of divergent structural specializations internally (Bailey, 1962, 1963c). The comparatively thin large leaves of adult plants have typical pinnate venation, their numerous lateral veins extending diagonally toward the margins of the lamina (Fig. 1).

Pereskias of such other species as *P. aculeata* Mill. (Bailey, 1962), *P. humboldtii* Britt. & Rose, *P. weberiana* K. Schum., *P. diaz-romeroana* Cárd. (Bailey, 1963a) and *P. guamacho* Web., *P. colombiana* Britt. & Rose, *P. cubensis* Britt. & Rose, and *P. portulacifolia* Haw. (Bailey, 1963d), although exhibiting variations in stature and habit of growth, as well as more or less incipient internal trends of divergent anatomical specializations, have leaves with pinnate venation (Bailey, 1960).

Many of the leaves of these taxa, with the possible exception of those of *P. aculeata* and *P. cubensis*, tend at times to form more extensively arcuate lateral veins (Fig. 2). Particularly in some leaves of *P. humboldtii* and related taxa of Peru and Bolivia, and in some aberrant ones of *P. guamacho* and *P. colombiana*, modifications of pinnate vasculature occur. In such leaves the lateral veins which diverge from the midvein in the basal and central part of the lamina become more conspicuous and extensively arcuate with concomitant reduction of those in the apical parts of the leaf (Fig. 3). These modifications of pinnate vasculature appear phylogenetically to be transitional toward the pseudopalmate and palmate venation which occurs in the comparatively thick succulent leaves of the structurally more highly specialized genera *Pereskiopsis* and *Quiabentia* (Figs. 4, 5).

The leaves of *Pereskia pititache* Karw. (*P. conzattii* Britt. & Rose), *P. autumnalis* (Eichlam) Rose, and *P. nicoyana* Web. are particularly significant in these connections. Not only are they more succulent than those of *P. sacharosa*, *P. bleo*, and *P. grandifolia*, but also vary markedly in size

[1] This investigation was financed by a grant from the National Science Foundation.

and form (Bailey, 1960). In some of them, the venation is of the modified pinnate form discussed in the preceding paragraph whereas in others the vasculature becomes truly pseudo-palmate and even closely palmate.

In the dicotyledons as a whole changes in patterns of foliar vasculature are not consistently unidirectional. Transitions from pinnate to palmate venation and vice versa are of not uncommon occurrence. Suggestive conclusions regarding phylogenetic changes in vasculature within a specific family therefore, are dependent upon extensive summations of cumulative circumstantial evidence. In the genera *Pereskia*, *Pereskiopsis*, and *Quiabentia*, a totality of evidence now available is strongly indicative of a phylogenetic transition from pinnate venation in structurally primitive pereskias to palmate vasculature in anatomically more highly specialized surviving representatives of *Pereskiopsis* and *Quiabentia* (Bailey, 1964a).

In his extensive survey of seeds, embryos, and seedlings, Ganong (1898) concluded that the Cactaceae is a family in which succulence and other adaptations for survival in excessively arid environments work backward phylogenetically into earlier and earlier stages of the development of the epicotyl, there commonly being conspicuous retardation in the appearance of such divergent changes in the cotyledons and hypocotyl of germinated embryos at least prior to growth of the plumule. If this retardation of evolutionary changes in cotyledons of the Cactaceae is as general as it appears to be, it is of possible significance to compare the cotyledonary vasculature in *Pereskia* with that in *Pereskiopsis* and *Quiabentia*. Of course it should be fully recognized in this connection that ontogeny does not closely parallel phylogeny in many cases. However, as recognized by Ganong, the divergent trends of specialization in the Cactaceae are so bizarre and so closely correlated from ecological and physiological points of view with adaptations for survival in arid environments as to leave few uncertainties regarding the directions in which phylogenetic changes are progressing. Furthermore, the Cactaceae is a family in which transitional stages of phylogenetic changes are more consistently and adequately preserved in surviving representatives than is commonly the case in many other families of the dicotyledons.

Thus far, I have been able to obtain seedlings of the following species through the kind assistance of Dr. Boke and other botanists.

Pereskia aculeata — Boke: from seeds collected by him.
Pereskia sacharosa — Boke: from seeds collected by Castellanos.
Pereskia grandifolia — Boke: from seeds collected by Steyermark.
Pereskia diaz-romeroana — Boke: from seeds collected by Cárdenas.
Pereskia humboldtii — Hutchinson #1452.
Pereskia pititache — Boke: from seeds collected and germinated by him.
Pereskia autumnalis — Moore #8210.
Pereskiopsis blakeana — Kimnach #82.
Pereskiopsis porteri — Kimnach #76.
Pereskiopsis — Boke: from seeds collected by MacDougal near Oaxaca.
Pereskiopsis — Boke B–5: from seeds collected at Totolapan, Oaxaca.
Pereskiopsis — Boke B–27: from seeds collected at Totolapan, Oaxaca.

In my paper on "Nodal anatomy in retrospect" (1956), I presented the results of an extensive reconnaissance of seedlings from 99 families of the dicotyledons. In 60 per cent of them the cotyledons are attached at 2-trace unilacunar nodes. Within this category there is a tendency at times in some families for the cotyledons to be pinnately veined (FIG. 9). In the structurally most primitive pereskias, viz. *P. sacharosa* and *P. grandifolia* which have pinnate venation in the leaves of both juvenile and adult plants, the cotyledons have this 2-trace pinnate form of vasculature. Therefore a totality of evidence suggests that the cotyledons of ancestral Cactaceae possessed pinnate venation during early stages of the differentiation of the family.

In the case of *P. sacharosa* and *P. grandifolia*, the thin oblong-elliptical or slightly ovate cotyledons, which are relatively small in seeds, continue to enlarge and appear to be physiologically functional for considerable time during earlier stages of the development of the juvenile plant, i.e., for a period which may be as extensive as several months. During the expansion of the cotyledons they retain their original form and internal pinnate venation. Particularly during the earliest stages of the enlargement of the cotyledons, the two traces commonly tend to be distinct and separate in the upper hypocotyl, at the nodal level, and in the basal part of the lamina (FIGS. 10, 12). During later stages of the enlargement of the cotyledons the xylems of the two traces tend to broaden and to become more or less closely approximated (FIGS. 11, 13). During such changes in the two traces, approximation of the two strands of phloem may be much less precocious than in the xylems.

The cotyledons in the large seeds of *P. aculeata* and of germinated embryos prior to development of the epicotyl are larger than those that occur in other representatives of the Cactaceae. These thin broadly ovate or slightly cordate cotyledons have a 2-trace pinnate form of vasculature (FIG. 14). The basal lateral veins are not extensively arcuate, thus resembling in this respect the venation in cotyledons of *P. sacharosa* and *P. grandifolia*.

In contrast to this the cotyledons in seeds of *P. diaz-romeroana* and *P. humboldtii* and of germinated embryos prior to the development of the epicotyl are much smaller than those of *P. aculeata* and are of more nearly oblong rather than ovate form. In my few seedlings of *P. diaz-romeroana*, the cotyledons have a simplified form of pinnate venation without conspicuous accentuation of the lateral veins (FIG. 17), whereas in those of *P. humboldtii* the cotyledons exhibit a tendency at times to accentuate the more extensively arcuate basal lateral veins (FIG. 16). It should be mentioned in this connection that the pereskias of Peru and Bolivia are much reduced in stature and commonly have very small leaves. This may be a factor in the simplified venation of early deciduous cotyledons of *P. diaz-romeroana*.

Pereskia pititache of which I have numerous seedlings has oblong-elliptical cotyledons with pinnate venation, but with a tendency to form extensively arcuate lateral veins (FIG. 15). However, they do not exhibit

transitions to truly pseudo-palmate vasculature such as occurs in the leaves of juvenile and adult plants. The cotyledons of the closely allied taxon, *P. autumnalis*, have similar somewhat modified pinnate venation.

The leaves of *Pereskiopsis* are very variable in size and form, not only in different collections of a taxon or clone when grown under different environmental influences, but frequently also in different parts of a single adult plant. Excessive emphasis by earlier taxonomists upon apparent differences in the form of leaves, when limited collections were available, has led to serious difficulties and uncertainties in identifying the numerous putative species of the genus. However, the leaves of adult *Pereskiopsis*, regardless of extreme variations in size and form and concomitant taxonomic uncertainties are comparatively succulent and consistently pseudo-palmately or palmately veined (FIGS. 4, 5). This is true except for the small first-formed leaves of some short shoots which may at times exhibit transitions from modified pinnate venation (FIG. 8) to palmate vasculature.

In seedlings of *Pereskiopsis porteri* (T. S. Brandeg.) Britt. & Rose, *P. blakeana* Ort., and three collections from Oaxaca of uncertain taxonomic affinities, the nearly oblong-elliptical cotyledons have a 2-trace pinnate form of vasculature (FIG. 18). At times the lateral veins which diverge from the mid-vein in basal and central parts of the lamina become accentuated in their arcuate extensions (FIGS. 19, 20), thus resembling in this respect the venation in cotyledons of *Pereskia pititache* and *P. humboldtii*.

The first-formed leaves of juvenile plants from these seed collections commonly vary more or less markedly in size and form. At times the ontogenetic sequences are complicated by the occurrence of rudimentary evanescent appendages with abnormal vasculature. Frequently the normal first-formed leaves differ strikingly from those of adult plants, tending to be narrowly lanceolate with fewer extensively arcuate lateral veins (FIG. 7) in contrast to the broader leaves of adult plants (FIG. 5). Not infrequently there is obvious ontogenetic retardation in the attainment of palmate venation; the first leaves of the juvenile stem having modified pinnate venation (FIG. 6) rather than truly palmate vasculature.

Thus, in agreement with work of Ganong (1898), the retardation in the attainment of pseudo-palmate and palmate venation in cotyledons of *Pereskiopsis* as well as in those of *Pereskia pititache* and *Pereskia humboldtii* strengthens a concept of divergent evolutionary change from pinnate to palmate venation in the Cactaceae. For, if the reverse were true, one would expect to find palmate venation in the leaves of the most primitive surviving representatives of the family and at least some cotyledons which retain palmate vasculature.

CONCLUSIONS

The Cactaceae is a family which provides unusually favorable evidence for the study of highly divergent trends of morphological specialization. These are so bizarre and so closely correlated from ecological and physiological points of view with adaptations for survival in arid environments

as to leave few uncertainties regarding the directions in which phylogenetic changes are progressing. Furthermore, an unusually comprehensive and adequate record of the divergent trends of specialization is preserved in surviving representatives of the family.

A totality of available evidence strongly indicates that ancestral Cactaceae had attained an advanced level of anatomical structure in their cambium, xylem, phloem, and cotyledons prior to the development of accentuated succulence and other trends of excessively divergent anatomical specializations (Bailey & Srivastava, 1962; Srivastava & Bailey, 1962). The ancestral trees and large shrubs of normal woody structure appear to have borne relatively broad thin leaves rather than succulent terete ones as in surviving representatives of the Opuntieae. The ancestral leaves evidently possessed typical pinnate venation and stomata of the "true rubiaceous" form (Bailey, 1964b). The germinated embryos, at least prior to the development of the epicotyl, had 2-trace unilacunar vasculature and both the cotyledons and first-formed leaves exhibited pinnate venation.

Evidence of a phylogenetic transition from pinnate to palmate venation in the relatively succulent leaves of *Pereskia pititache*, *P. autumnalis*, *P. nicoyana*, *Pereskiopsis*, and *Quiabentia* is now available. In this connection, retardation in the extension of palmate venation into cotyledons of *Pereskia* and *Pereskiopsis* as well as in the first-formed leaves of the latter genus provides corroborative evidence of considerable significance regarding a phylogenetic transition from pinnate to palmate vasculature in the Cactaceae.

It should be noted in conclusion that summations of evidence available in the most primitive surviving representatives of the Cactaceae suggest that ancestral members of the family may have possessed spines and hairy areoles during earlier stages of their differentiation as a family. More significant from physiological and biochemical points of view appear to be the likelihood that ancestral Cactaceae possessed abundant mucilage cells and an incipient tendency in their metabolism toward the formation of unusually abundant crystals of calcium oxalate and other calcium salts of organic acids (Bailey, 1965). Furthermore there appears to have been an incipient tendency toward the storage of unusually abundant starch in the secondary xylem of the main stem and the larger roots of mature plants. and likewise at times for the accumulation of large amounts of stored protein.

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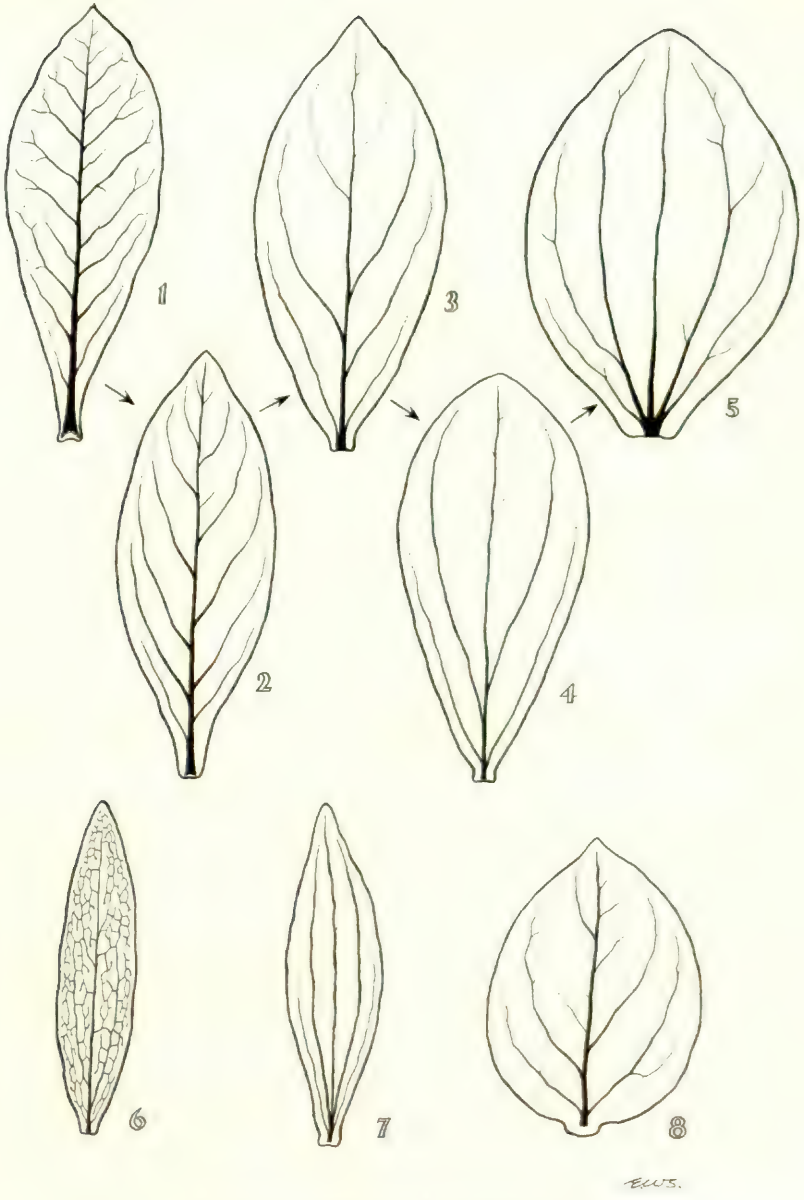
EXPLANATION OF PLATES

PLATE I

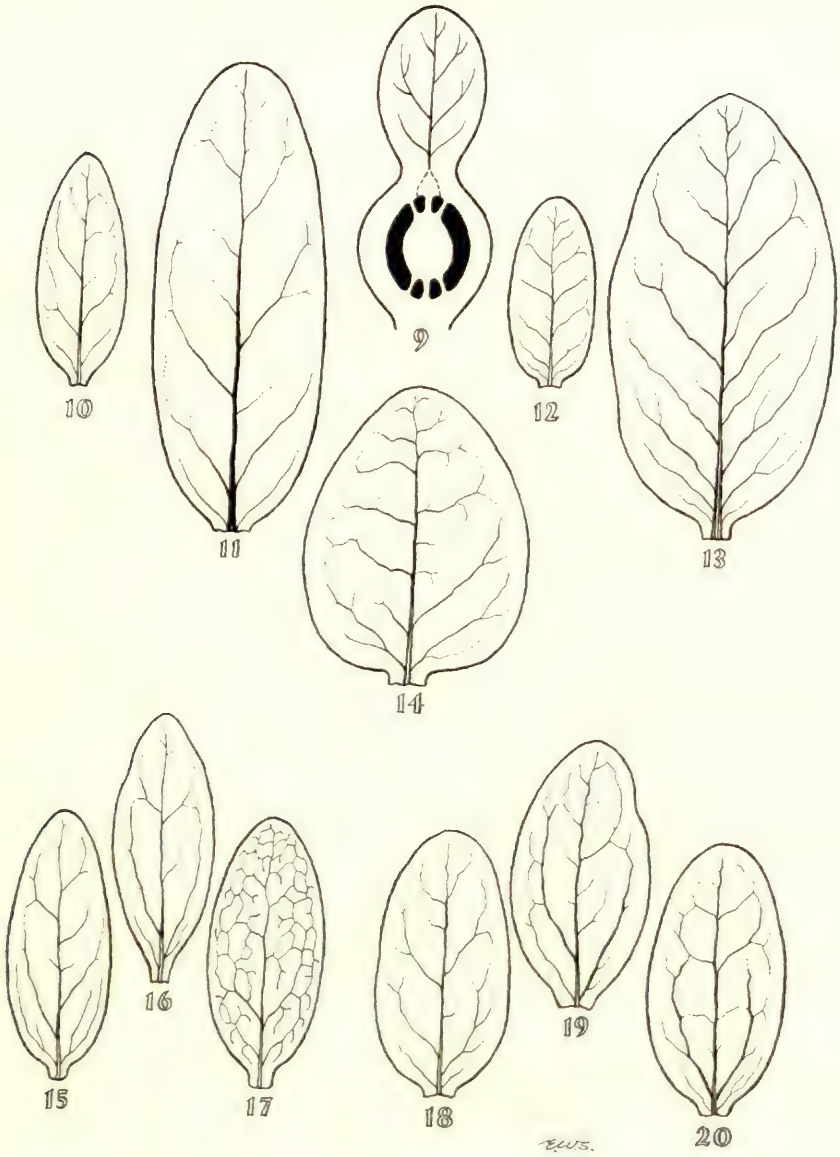
FIGS. 1–8. Leaves of *Pereskia* and *Pereskiopsis* showing midvein and principal lateral veins. Finer details of vasculature omitted except in FIG. 6. Actual size of leaves variously reduced and enlarged. 1, Form of vasculature in most primitive category of pereskias. 2, Pinnate venation with extensively arcuate lateral veins. 3, Modified pinnate venation with accentuation of arcuate lateral veins diverging from midvein in basal and central part of the lamina. 4, Pseudo-palmate venation. 5, Palmate venation. 6, Modified pinnate venation in lanceolate leaf of juvenile stem of *Pereskiopsis* [*Boke B-5*]. 7, Pseudo-palmate venation in lanceolate leaf of juvenile stem of *Pereskiopsis* [*Boke B-27*], compare with FIG. 5 for form and venation in leaf from adult plant. 8, Modified pinnate venation in first-formed leaf of short shoot of *Pereskiopsis blakeana* [*Boke B-33*]. Drawn by Elmer W. Smith.

PLATE II

FIGS. 9–20. Cotyledons of *Pereskia* and *Pereskiopsis* comparably enlarged to approximately × 1.7. Finer details of venation omitted except in FIG. 17. 9, Diagrammatic illustration of pinnately veined cotyledon attached at a 2-trace unilacunar node. 10, *Pereskia sacharosa* cotyledon prior to the development of the juvenile stem. 11, *The same*, during final stage of its enlargement. 12, *Pereskia grandifolia* prior to the development of the juvenile stem. 13, *The same*, during final stage of enlargement. 14, *Pereskia aculeata*, cotyledon prior to the development of the juvenile stem. 15, *Pereskia pititache*, cotyledon with modified pinnate vasculature. 16, *Pereskia humboldtii*, cotyledon with modified pinnate venation. 17, *Pereskia diaz-romeroana* cotyledon with entire venation. 18, *Pereskiopsis* [*Boke B-5*] cotyledon with normal pinnate venation. 19, *Pereskiopsis blakeana*, cotyledon with basally modified pinnate venation. 20, *Pereskiopsis porteri*, cotyledon with basally slightly modified pinnate venation. Drawn by Elmer W. Smith.



BAILEY, LEAF-BEARING CACTACEAE, XIV



BAILEY, LEAF-BEARING CACTACEAE, XIV

COMPARATIVE ANATOMY OF THE LEAF-BEARING CACTACEAE, XV

SOME PRELIMINARY OBSERVATIONS ON THE OCCURRENCE OF "PROTEIN BODIES"

I. W. Bailey [1]

In the ninth paper of this series (1963c), I called attention to the occurrence of filamentous bodies in the vessels of *Pereskia sacharosa* Griseb., *P. grandifolia* Haw., *P. bleo* DC., and *P. tampicana* Web. which are rarely, if ever, present in the vessels of other categories of *Pereskia* or in those of *Pereskiopsis* and *Quiabentia*. These structures differ markedly in size and form. Many of them are tenuous threads a fraction of a micron in diameter, which are variously elongated, oriented, and aggregated (Figs. 1 & 3). Others are coarse strands up to ten micra in diameter and of varying lengths and formations (Fig. 4). Some of the smaller more compact aggregations of slender filaments resemble the filamentous forms of "protein bodies" originally found and intensively investigated by Molisch (1885, *Figs. 3 & 5*) in the outer parenchymatous living tissue of young stems of *Epiphyllum*.

In the secondary xylem of this anatomically most primitive category of pereskias (Bailey 1962, 1963c) globular forms of bodies may occur in parenchymatous cells adjacent to vessels (Figs. 5 & 6), in the first-formed unlignified parts of rays in roots and infrequently in lignified ray cells which contain abundant starch. Filamentous and stellate bodies are in general of rare occurrence in parenchymatous cells of the xylem except at times in the innermost parts of the rays in roots.

In the main stem and larger roots of *P. sacharosa* collected for me by Carenzo and Legname, from a tree in its native habitat in Jujuy province of northern Argentina, large deposits of material occur in the unlignified parenchyma of the broad zone of secondary phloem. These bodies vary considerably in form. The last formed cells of the multiseriate rays commonly contain abundant minute more or less spiny granules with frequent transitions to relatively large stellate bodies composed of short, slender, radially oriented filaments (Fig. 2). Cells in the outer modified parts of the rays and of the inner cortex frequently contain nearly globular bodies.[2] Filamentous forms resembling those which occur in the vessels of the secondary xylem are of sporadic occurrence in ray cells of the phloem, but may be present at times in the axially oriented parenchymatous cells of parts of the phloem which contain or once contained functioning sieve tubes.

[1] This investigation was financed by a grant from the National Science Foundation.

[2] In using the term globular, I include some deviations from perfectly spherical form to hemispherical, ovate, and irregularly roundish compact bodies.

The only collections of *P. tampicana* available to me are young stems of cultivated plants obtained by Dr. Boke at Victoria in Tamaulipas, Mexico. These small stems with scanty xylem and phloem have filamentous bodies in their vessels and globular ones in parenchyma adjacent to vessels (FIG. 6). Although most of the unlignified parenchyma of the phloem and cortex does not contain stellate or globular bodies, some of the ray cells and axially oriented ones (more or less closely associated with sieve tubes) are filled with deposits of diversified forms. These vary from slender filaments to coarse strands (as in the vessels of the xylem) and exhibit various transitions to homogeneous appearing masses of diversified forms, sizes and orientations (FIG. 7).

At present there are serious taxonomic difficulties and uncertainties in dealing with *P. grandifolia*, *P. bleo*, and such putative segregates as *P. moorei* Britt. & Rose and *P. bahiensis* Gürke. These uncertainties are much intensified in the case of plants growing in greenhouses and botanical gardens remote from their native habitats. Regardless of whether these plants are ultimately shown to be closely related distinct species or merely geographical variants of a single widely ranging taxon, it is significant that the anatomy of their stems and roots is remarkably similar (Bailey 1961, 1963c). Therefore, in discussing the occurrence of "protein bodies" I shall confine myself at this time to collections from mature plants growing in Brazil, Venezuela, and Costa Rica.

In material of *P. grandifolia* kindly collected for me by Dr. Castellanos in Brazil, filamentous bodies occur in the vessels of stems and roots. The phloem of the larger roots contains abundant deposits of bodies in its ray and axially oriented parenchyma. These bodies are more or less closely aggregated minute hollow appearing globules or small rings, but exhibit frequent transitions to stellate forms as in *P. sacharosa*. The bodies in the phloem of the main stem are of similar forms but less abundant.

In specimens of a mature plant, either *P. grandifolia* or *P. bleo*, kindly collected for me by Dr. Steyermark in Venezuela, filamentous bodies occur in the vessels of both stems and roots, and globular ones in parenchymatous cells adjacent to vessels. The ray cells in the broad secondary phloem of the main stem and larger roots are densely packed with granular and globular contents, as are the unlignified cells in the first formed parts of the rays of the xylem in roots. In the tangentially expanded cells of the cortex, there are transitions to ring-shaped bodies (FIG. 9) and to frothy- or vacuolated-appearing formations (FIG. 10). In these cortical cells coarsely filamentous bodies are of sporadic and infrequent occurrence.

In material of an adult plant, either *P. grandifolia* or *P. bleo*, kindly collected by Dr. Rodríguez in Costa Rica, there is a tendency at times for fewer of the vessels to contain filamentous bodies than in comparable material of the two preceding collections from Brazil and Venezuela. The ray cells and axially oriented parenchyma in the broad zone of the secondary phloem of the main stem contain very abundant globular bodies. Where excessively abundant, they tend to fuse in highly diversified formations, viz. convoluted coarse strands, massive rings, and lobate

formations (Fig. 8). Slender filamentous bodies are of sporadic and infrequent occurrence. The phloem in large roots of this plant contains less abundant deposits in finely globular forms, hollow appearing bodies, or rings of diverse sizes which when very abundant fuse to form extensive vacuolated or frothy deposits.

In a second category of pereskias [3] which includes *P. aculeata* Mill., *P. humboldtii* Britt. & Rose and allied taxa, and *P. pititache* Karw. (*P. conzattii* Britt. & Rose) and related species, globular bodies tend to occur in the xylem and phloem of stems and roots, filamentous forms being absent in my collections of these plants.

Within this category of pereskias, *P. pititache*, *P. autumnalis* (Eichlam) Rose and *P. nicoyana* Web. exhibit less divergent trends of anatomical specializations except in the basal parts of their large trunks (Bailey, 1963b). Globular bodies are of less abundant occurrence in the secondary xylem except at times in the first-formed parts of the rays in roots. In ray cells and axially oriented parenchymatous ones of the phloem, the globular bodies although varying considerably in size and number, commonly tend to be comparatively few and of relatively large size. However, they may fuse at times into beaded or lobed formations (Fig. 11).

In *P. humboldtii* and related taxa of Peru and Bolivia, which are of more or less reduced and modified stature, advanced trends of divergent anatomical specializations occur in the roots (Bailey, 1963a); those species being characterized by forming much enlarged tuberous swellings. The size and the distribution of globular bodies in the secondary xylem and phloem of the stems of these plants resemble those that occur in *P. pititache* and allied taxa. However, in some stems the parenchymatous cells of the phloem and cortex tend to form extensive massive deposits, but without the transitions to filamentous structures such as occur in *P. tampicana*. In parts of the root system, bodies of globular forms are abundant in the rays of the secondary xylem. Where closely aggregated, they may at times exhibit transitions to lobed formations or to short rods.

From ecological and physiological points of view, it is particularly significant that the soft succulent tissue in the large tuberous swellings is devoid of globular bodies as well as starch, but contains numerous large cells with mucilaginous contents and others with druses of calcium oxalate. This suggests that the tubers may function at least seasonally in the retention of moisture rather than as organs for the storage of starch and other food substances.

The scandent *P. aculeata* is anatomically the most divergently specialized representative of the genus *Pereskia* (Bailey, 1962). The variations in the structure of the stems and roots are so extensive and highly variable as to necessitate more adequate collections of this species than are available to me at present before reliable generalizations regarding the occurrence of globular bodies can be attained. In available material of stems and roots, the parenchymatous cells of the pith and cortex as well as those

[3] For a description of three anatomically distinct categories of pereskias see the second paper of this series (1961).

of the xylem and phloem contain abundant starch. Few of them contain granular and globular bodies. Filamentous and stellate bodies do not occur in the secondary phloem, nor in vessels of the xylem. The tyloses in vessels frequently contain abundant starch but infrequently globular bodies in addition. In some stems and roots, the cells of the phelloderm are devoid of starch and contain abundant granular and small globular forms of material.

Pereskias of the third category, viz. *P. guamacho* Web., *P. colombiana* Britt. & Rose, *P. cubensis* Britt. & Rose and *P. portulacifolia* Haw., tend to form trees under favorable environmental conditions. Divergent trends of anatomical specializations are largely confined to the roots (Bailey, 1963d), but without leading to the formation of tuberous enlargements such as characterize the pereskias of Peru and Bolivia. In the xylem and phloem of stems and roots of the four species, the bodies when present tend to be of globular forms, stellate and filamentous ones being absent. In some collections of *P. guamacho*, where the globular bodies become very abundant and closely aggregated in cells of the secondary phloem, transitions to more massive irregularly rounded deposits and frothy- or vacuolated-appearing ones occur in the ray and axially oriented parenchyma (FIG. 10).

It should be noted in passing that in the first category of pereskias, which characteristically tend to form filamentous bodies in many of their vessels, some of the fully matured lignified vessels may contain merely vestiges of protoplasmic contents and at times globular bodies. In the second and third categories of pereskias, which do not form filamentous deposits in their vessels, vestiges of protoplasmic contents may likewise persist in some of the fully matured vessels. Occasionally globular deposits may occur in a vessel as well as in parenchymatous cells adjacent to it.

In striking contrast to *Pereskia* the cells in comparable stems and roots of the relatively succulent and anatomically more divergent genera *Pereskiopsis* and *Quiabentia* (Bailey, 1964) do not contain filamentous, stellate or massive deposits of material. This is true regardless of whether collections were obtained from greenhouses, botanical gardens or from adult plants growing in their native arid environments. Although diversified forms of "protein bodies" do not occur in my extensive collections of stems and roots of *Pereskiopsis* and *Quiabentia* as they do in *Pereskia* when preserved in FAA,[4] conspicuous spindle-shaped ones occur at times in the epidermal and sub-epidermal cells of living leaves of *Pereskiopsis* [*Boke B-18*] when grown in a greenhouse at Norman, Oklahoma. These bodies closely resemble in size and form those encountered by Molisch (1885, *Fig. 1*) in living tissue of *Epiphyllum*. In the epidermis the bodies, commonly one to each cell (FIG. 12), are oriented parallel to the surface of the leaf, whereas in the mesophyll they are arranged more or less at right angles to the surface. As in *Epiphyllum*, the spindles are composed

[4] Forty per cent formaldehyde, five parts: glacial acetic acid, five parts: 50 per cent ethyl alcohol, ninety parts.

of more or less closely compacted aggregations of slender filaments arranged parallel to the long axis of the body. In living cells, the bodies are conspicuously anisotropic in polarized light, indicative of crystalline composition. In some leaves, the bodies consist at times of diffusely aggregated strands of coarser texture. Bodies of similar size and form occur in some living leaves of *Pereskia aculeata* and *P. grandifolia*.

Such occurrences in living leaves of *Pereskia* and *Pereskiopsis* suggest that material conveniently available in greenhouses should provide favorable specimens, not only for a reconnaissance of the occurrence of spindle-shaped bodies in various species of *Pereskia* and *Pereskiopsis*, but also critical material for detailed cytological, physiological, and biochemical investigations.

DISCUSSION

The structures dealt with on preceding pages obviously are extraordinarily variable in size, form, abundance, and distribution in different parts of a plant, but commonly exhibit transitions from one form to another, not only in neighboring cells of the same tissue, but also within the limits of a single cell. This is suggestive of possible fundamental similarities in their composition.

In the case of living tissue of *Epiphyllum*, which contains many of the essentially similar diverse forms of these bodies, Molisch's extensive tests of the solubilities, color reactions, and general behavior of the bodies in acids, alkalies, and various other chemical reagents provided much cumulative evidence in substantiation of proteinaceous composition.

In my collections of stems and roots preserved in FAA the diverse forms of the bodies give consistently rapid positive tests with Millon's reagent, as do the spindle-shaped ones in living leaves of *Pereskiopsis* prior to their longitudinal contraction, lateral expansion, and ultimate solution. Unfortunately this test, *by itself*, is not conclusive proof of solely proteinaceous composition. However, in stems and roots fixed in FAA, the bodies of crystalline and amorphous forms give a positive violet coloration with the Biuret test. The crystalline spindle-shaped bodies in living leaves dissolve so rapidly in copper sulphate and sodium hydroxide that it is difficult to obtain a reliable positive test with the Biuret reagents. But, when the living tissue is killed with the aldehyde fixatives now utilized in light and electron microscopy, the bodies persist for a number of days giving a positive violet coloration with the Biuret test. Furthermore, when sections are treated with acid fuchsin the bodies stain as do other cell constituents of known proteinaceous composition. In addition, the consistent similarity in the staining of the bodies and that of cell inclusions of known proteinaceous composition when treated with toluidine blue, Haedenhein's iron alum haematoxylin, and other staining reagents, provides much cumulative corroborative evidence. Thus, there appears to be no valid objection to concluding that the bodies in question are at least of partly proteinaceous composition.

Of course, in dealing with the color reactions of the smaller forms of the diversified bodies, it is essential to differentiate them with care from nuclei, coagulated protoplasm, plastids, and from deposits of "slime" in sieve tubes.

The common occurrence and abundance of the diverse forms of protein bodies raises a number of fundamental questions regarding metabolic phenomena in cells of the Cactaceae. In my extensive collections, such bodies do not occur in cells concerned in the formation of mucilage or crystals of calcium oxalate. Nor do they occur in the lignified libriform fibers which function at least seasonally in the storage of starch. Although not invariably absent in lignified parenchyma containing starch or invariably present in unlignified cells devoid of starch, there appears in general to be an inverse correlation between metabolic activity in cells concerned in the storage of starch and that during the deposition of abundant protein bodies.

In the case of plants growing in their arid native habitats, the abundance of proteinaceous bodies in the basal part of the main stem and larger roots raises questions of much ecological, physiological, and biochemical significance. Are such occurrences indicative of at least seasonal accumulation of reserves of utilizable proteinaceous substances? Molisch concluded that the protein bodies are reserve products whereas Chmielewsky (1887) regarded them as excretions. Neither of these investigators provided conclusive evidence in support of their generalizations. The filamentous bodies in fully matured vessels of the xylem and those in crushed dead parts of the phloem may no longer be potentially available to the plants and thus might be regarded as excretory. The only evidence available to me at present in favor of Molisch's interpretation is in two plants having affinities to *Pereskia sacharosa*. In the case of specimens obtained by Carenzo and Legname from a plant growing in its native habitat in northern Argentina, the collections were made during the resting, "winter" season after abscission of the leaves. In this plant, as indicated earlier in this paper, abundant protein bodies occur in the basal part of the main stem and larger roots. On the contrary, in comparable material collected for me by Dr. Cárdenas during the active growing and flowering season, but from a plant at somewhat higher elevation in Bolivia, filamentous bodies are present in the vessels, but diverse forms of proteinaceous bodies are absent or of sporadic occurrence in the phloem, cortex, and phelloderm. In spite of possible taxonomic and environmental uncertainties, this at least suggests that proteinaceous material in living cells of the phloem and cortex, present during the resting season, may be utilizable during seasons of active growth. More adequate and conclusive evidence can be obtained only by detailed investigations of living plants of the same taxon growing together in the same habitat and at different seasons of the year.

Evidence obtainable from my preliminary investigations of the form, distribution, and abundance of protein bodies in more or less haphazardly available collections indicates much variability in different tissues, not only in different collections of the same taxon, but also in stems of differ-

ent sizes and stages of development within the same plant. For adequate clarification of the significance of this variability it will be necessary to study the living tissues of stems and roots of plants growing in their native arid environments. From significant ecological, physiological, and biochemical points of view it is essential that this be done, particularly in adequate correlation with metabolic phenomena involved in the production of mucilage, of large amounts of organic acids and their calcium salts, and also in the accumulation and possible seasonal depletion of unusually abundant starch in the secondary xylem of large stems and roots.

It should be noted in conclusion that my collections from adult plants growing in their native habitats were preserved in FAA. The diverse forms of protein bodies in stems and roots have not dissolved after prolonged treatment in this fixative and subsequent mounting in diaphane for permanent slides. However, the possibility exists that changes in form may be induced by fixation in FAA. Molisch (1885) found that in the case of living cells of *Epiphyllum* the elongated and spindle forms of the bodies contracted longitudinally and expanded laterally prior to dissolving in acids and other reagents. The spindle-shaped bodies in living leaves of *Pereskiopsis* behave similarly. Even in the least drastically modifying modern methods of fixation, the spindles may expand, or they may contract more or less laterally and at times even longitudinally. Transitions from anisotropic crystalline composition to isotropic amorphous form occur in some reagents.

The persistence of anisotropic filaments and elongated bodies in association with isotropic globular ones in the same section of a stem or root makes it appear unlikely that all of the amorphous globular and more massive forms are due to modifications of crystalline filamentous ones in FAA. I had hoped to test the possibility of such changes by obtaining living material from easily accessible greenhouses. Thus far none of the numerous stems from the unnatural environments of greenhouses contain protein bodies after fixation in FAA with exception of two collections from the Missouri Botanical Garden. Unless I can obtain living stems of such sporadically occurring specimens in greenhouses, it will be necessary to study the behavior of globular forms of bodies in living stems and roots of plants growing in their native habitats.

The presence of filamentous bodies in the vessels of one category of pereskias and their absence in the vessels of two other categories, and of *Pereskiopsis* and *Quiabentia* provides some evidence of considerable taxonomic significance. However, the occurrence, distribution, and diversified forms of the protein bodies in haphazard collections of the second and third categories of pereskias are highly variable. Before utilizing conspicuous differences in the form and distribution of protein bodies as reliable diagnostic criteria in differentiating species, extensive collections of different plants must be obtained and studied in detail. Such an extensive investigation is hardly justifiable from a solely taxonomic point of view unless significant ecological, physiological, and biochemical data are obtained at the same time.

ACKNOWLEDGMENTS

I am greatly indebted to Dr. Norman Boke for his continued kindness in sending me material of living plants growing in his greenhouse.

I am also indebted to Dr. Lalit Srivastava for his kind assistance in making slides of living leaves fixed in acrolein and stained in toluidine blue.

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EXPLANATION OF PLATES

(All "protein bodies" stained with Millon's reagent or Haedenhein's iron-alum haematoxylin for photographic purposes.)

PLATE I

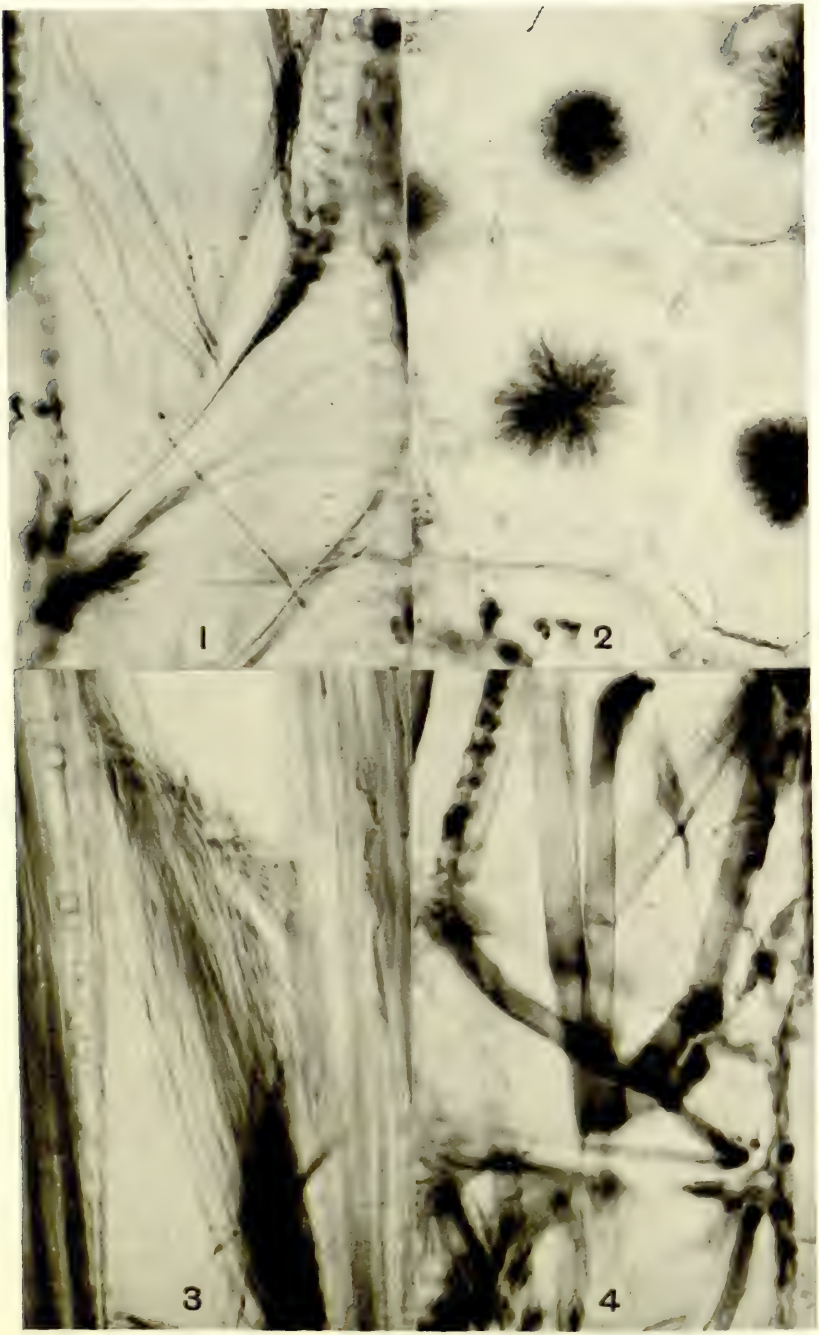
FIGS. 1–4. "Protein bodies" in *Pereskia*, × 510. 1, Diffusely distributed tenuous filaments in vessel of *P. grandifolia*. 2, Stellate aggregations of tenuous filaments in unlignified phloem parenchyma of *P. sacharosa*, stained in Millon's reagent. 3, Aggregated filaments in vessel of *P. tampicana*. 4, Coarse strands and tenuous filaments in vessel of *P. grandifolia*.

PLATE II

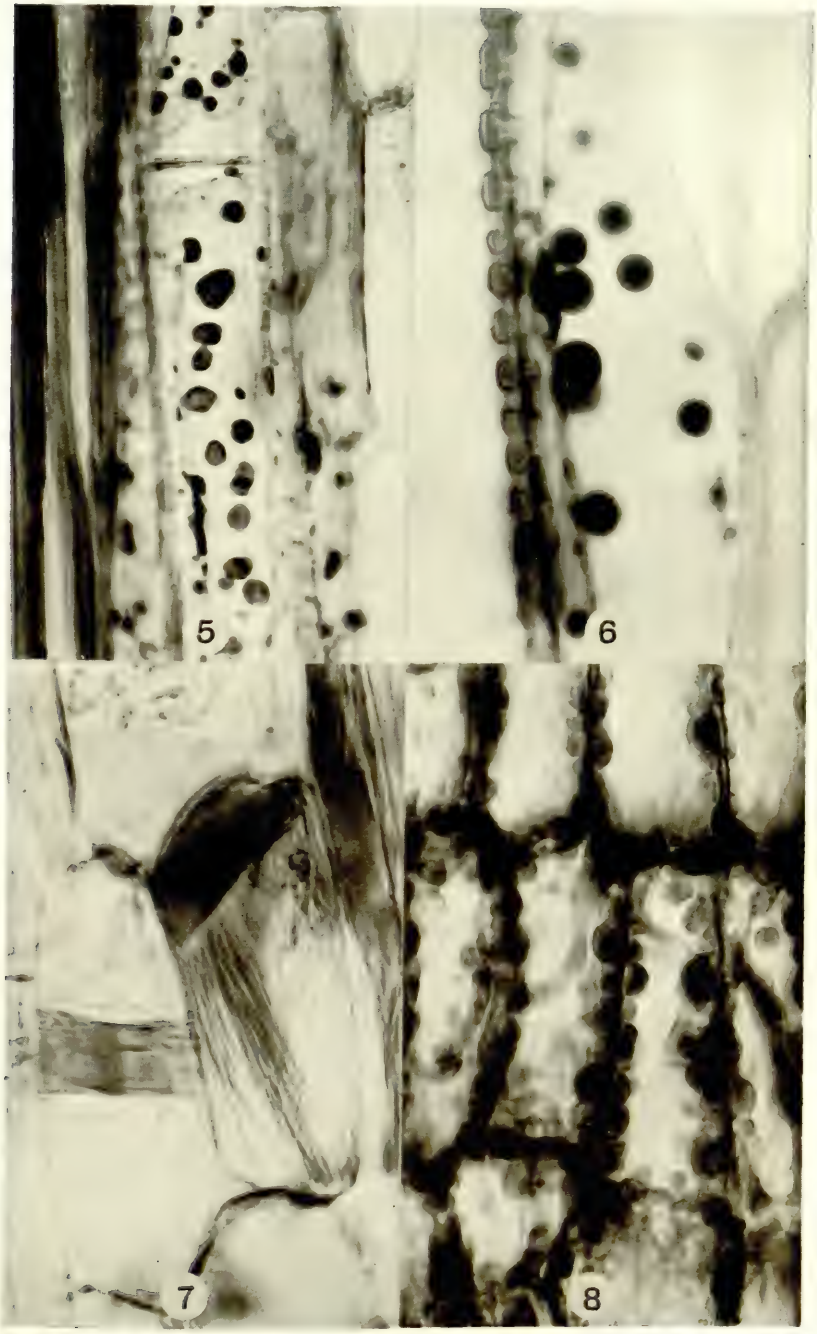
FIGS. 5–8. "Protein bodies" in *Pereskia*, FIGS. 5, 7, and 8 × 510, FIG. 6 × 1130. 5, Globular bodies in axially oriented wood parenchyma adjacent to vessel of *P. tampicana*. 6, Globular bodies in ray cell adjacent to vessel of *P. tampicana*. 7, Transitions from tenuous filaments to massive plates in phloem parenchyma of *P. tampicana*. 8, Spherical and hemispherical bodies in phloem parenchyma of *P. bleo*; bodies adhering to walls of cells with transitions to coarse convoluted strands.

PLATE III

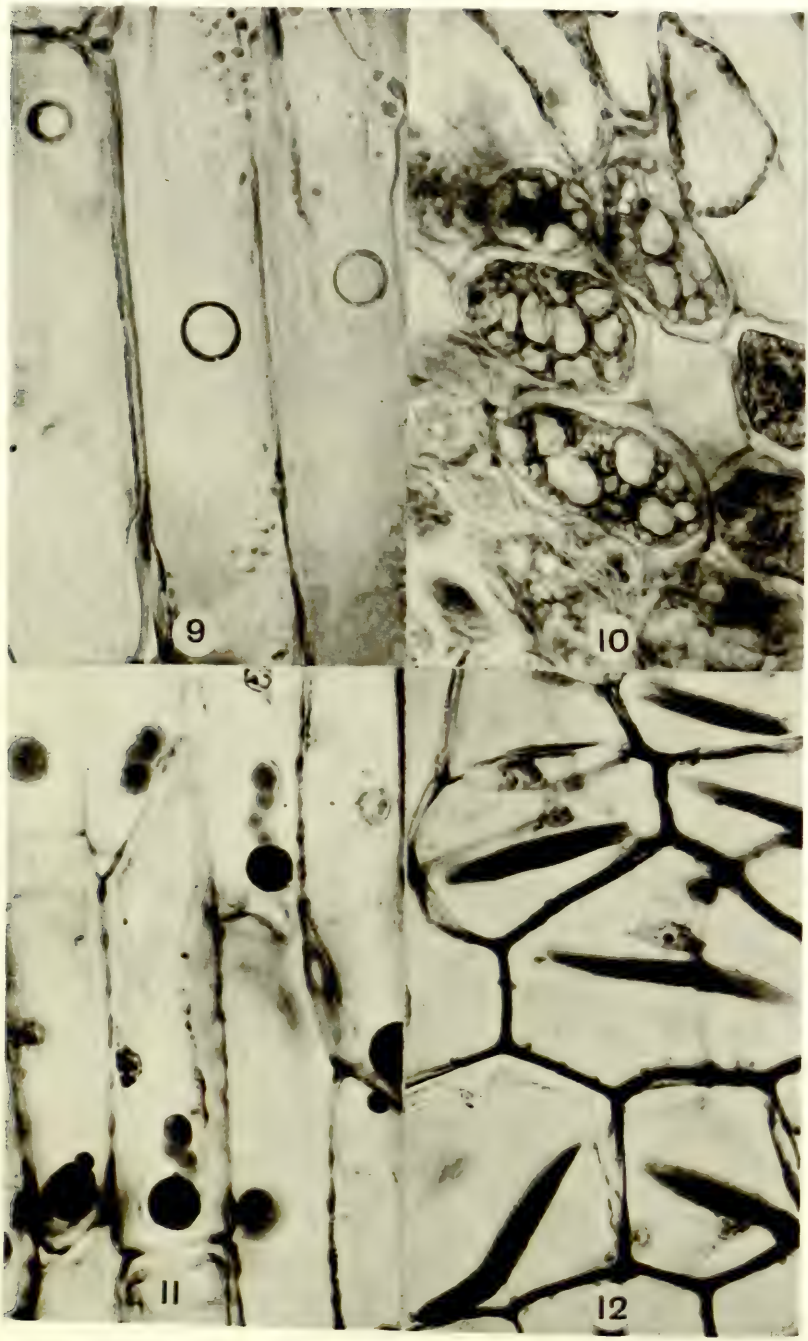
FIGS. 9–12. Diversified forms of "protein bodies" × 510. 9, Large rings in outer cortex of *P. bleo* (compare Molisch *Fig. 2*). 10, Vacuolated or frothy appearing deposits in phloem ray cells of *P. guamacho*. 11, "Protein bodies" in axially oriented phloem parenchyma of *P. pititache*. 12, Spindle-shaped bodies in leaf of *Pereskiopsis* [*Boke B-18*], nucleus with nucleolus near spindle in central cell of this figure stained in Haedenhein's iron-alum haematoxylin.



BAILEY, LEAF-BEARING CACTACEAE, XV



BAILEY, LEAF-BEARING CACTACEAE, XV



BAILEY, LEAF-BEARING CACTACEAE, XV

THE DIRECTOR'S REPORT

The Arnold Arboretum During the Fiscal Year Ended June 30, 1965

The Arnold Arboretum was twice honored during the year: by the Massachusetts Horticultural Society and by the United States Department of the Interior. The Trustees of the Massachusetts Horticultural Society voted in November to award the large Gold Medal of the Society to the Arnold Arboretum for its horticultural leadership. The citation accompanying the medal notes that "new plants from the far corners of the world and new originations by its geneticists are combined with the rich collections of the past to enable the plant lover to watch their growth and evaluate their beauty. Its library, publications and herbarium are world renowned. Everyone who gardens owes it to himself to visit and benefit from this great horticultural center." Dr. Carroll E. Wood, Jr. accepted the medal for the Arboretum staff from Mr. Oliver Wolcott, President, during the annual meeting of the Society.

In January, the Secretary of the Interior, Stewart L. Udall, announced that the Arnold Arboretum was designated for recognition as a National Historic Landmark. The nominating citation read, "As well as being a beautiful park, the Arnold Arboretum is now America's pre-eminent institution for research in woody plants." The award was accepted jointly by Mayor John F. Collins, for the City of Boston, as owner of the land; by Commissioner William J. Devine, for the Department of Parks and Recreation, for its maintenance service of portions of the property; and by Mr. Nathan M. Pusey, for the President and Fellows of Harvard College, trustees of the Arboretum and responsible for its staff, collections, and research contributions. About 500 institutions or localities have been similarly honored throughout the country. Those responsible for the Arboretum agree to preserve so far as practicable and to the best of their ability, the historical integrity of this important part of the national heritage, "to continue to use the property only for the purposes consistent with is historical character." The Arboretum will be listed in official government publications of such sites but will not receive financial support, nor will there be any change in the joint operation of the Arboretum by the City of Boston and Harvard University. A bronze plaque will be placed on the Arboretum grounds during the next year.

Staff:

It is with deep regret that we report the deaths of Mrs. Susan Delano McKelvey on July 11, 1964, and of Mrs. Dorothy H. Marsh on April 13, 1965. Last year we reported Mrs. McKelvey's desire to retire from active

service on the Committee to Visit the Arnold Arboretum and as a Research Associate on the Arboretum staff. Her death such a very short time later was unexpected. In a biographical sketch and bibliography, published in the *Journal of the Arnold Arboretum* (46: 45–47. 1965), we have recorded her contributions as an outstanding horticulturist.

Mrs. Marsh worked part time as an artist on the project concerned with the Generic Flora of the Southeastern United States. Her illustrations of many of the critical genera of the area have been and will for some time to come be published in the continuing studies of the Flora which appear in the *Journal of the Arnold Arboretum*. The accuracy and high artistic quality of these drawings add immeasurably to the value of the published works.

The appointment of Dr. Lorin I. Nevling, Jr., as Associate Curator, without limit of time, was approved during the year. Dr. Nevling serves as Supervisor of the Herbarium of the Arnold Arboretum and Supervisor of the Herbarium of the Gray Herbarium on joint and simultaneous appointments.

Three new annual appointments were made during the year. Dr. Thomas Gordon Hartley, a graduate of the University of Iowa, has spent the past three years as botanist on a phytochemical survey of the native vegetation of Papua and New Guinea. His special familiarity with that vegetation will be of value in studies of our herbarium collections from the area. Dr. Ian Keith Ferguson, a graduate of Trinity College of the University of Dublin, was appointed to work with Dr. Wood on the Generic Flora of the Southeastern United States. Mr. Henry Barnes Hosmer was appointed an honorary Research Associate. The Arboretum will gain much from his interest in the introduction to this country of native plants of Afghanistan.

The appointment of Dr. Mary Elizabeth Sanders as a Research Fellow was renewed. Dr. Sanders holds the North Carolina-Sandeen Fellowship of the American Association of University Women.

Mr. Arnold David Clapman has been engaged as an artist to succeed Mrs. Marsh on the Flora project.

Mercer Research Fellowships for varying periods of time were awarded during the year to five scholars whose work would be aided by access to the collections of the Arnold Arboretum. Mr. Arturo Gómez Pompa, of the National University of Mexico and of its Botanical Garden, who came here as a Guggenheim Fellow, continued, as a Mercer Fellow, his work on the vegetation of Veracruz, Mexico. Dr. Hermanus Philippus van der Schijff, of the University of Pretoria, Republic of South Africa, who arrived in January, is working in the laboratory of wood anatomy on problems of stem enlargement. Dr. Hans U. Stauffer, of the University of Zurich, stopped briefly to examine materials of the Santalaceae. Dr. H.-Christian Friedrich, of the University of Munich, studied material of the Aizoaceae. M. Michel Colon, a recent graduate of the Royal School of Horticulture at Vilvorde, Belgium, spent several months taking part in various operational activities of the Arboretum to become familiar with

this type of horticultural enterprise. Mr. Edward A. Murray, a graduate student of Pennsylvania State University, spent three months examining living and herbarium collections of the maples.

We record also the departure of Dr. Lalit M. Srivastava, who held a Mercer Research Fellowship for three years, and of Dr. Shirley A. Graham, who worked for a year on the project of the Generic Flora of the Southeastern United States.

Honors and assignments came to various members of the staff during the year. Mr. Alfred Fordham was appointed to the research committee of the Massachusetts Nurserymen's Association and to the cultivar testing committee of the International Plant Propagators' Society. Mr. Peter Green was elected secretary for a five-year term at the meeting of the International Association of Botanic Gardens. Dr. Howard was reappointed to the board of the Division of Botany of the International Union of Biological Sciences as a representative of the Section of General Botany. He serves as past President and a member of the board of the International Association of Botanic Gardens and as a council member of the Association for Tropical Biology. Dr. Karl Sax, Professor *emeritus*, served as Sigma Xi lecturer during a portion of the year, as visiting professor of genetics at Cornell University in the fall of 1964, and as Research Associate on a Public Health Service grant at the University of Georgia during the winter trimester. He was awarded an honorary degree of Doctor of Science, at Commencement exercises, in June, from the University of Massachusetts. Dr. Bernice Schubert continues as a member of the Editorial Board of the Bulletin of the Association for Tropical Biology. Dr. Carroll Wood was reappointed to the Subcommittee for Family Names of the Committee for Spermatophyta at the Nomenclature Section of the X International Botanical Congress at Edinburgh.

Dr. Wyman was elected President of the Horticultural Club of Boston. He continues as a Director of the American Horticultural Society and as chairman of its Awards Committee. He is a member of the organizing committee for the XVII International Horticultural Congress to be held in Maryland in 1966, and chairman of the "amateur section" of that Congress. During the year Dr. Wyman was honored three times for his horticultural writings. The International Shade Tree Conference awarded him an honorary membership and plaque in appreciation of his interest in promoting the planting and preservation of shade and ornamental trees. The National Council of State Garden Clubs presented him with a certificate of merit in recognition of distinguished service in promoting literary horticultural interest. Finally, the Garden Club of America Medal of Honor was awarded to "Dr. Donald Wyman, Horticulturist of the Arnold Arboretum of Harvard University, whose energy, ability and contributions to horticulture are outstanding."

Horticulture:

The successful growing of plants in New England is becoming dependent on an apparently decreasing summer rainfall. Although mention

The summer of 1964 was exceedingly dry. ABOVE: The largest pond along the Meadow Road in the Arboretum completely dry. BELOW: The Boston Fire Department assisted the staff in extinguishing a fire in the dry grass and the conifer collection.

has been made of the drought conditions in previous reports, the cumulative effect of successive summers deficient in rainfall are now conspicuous and serious. Three of the first four months of the calendar year 1964 exceeded the expected or mean rainfall by 10 per cent, but seven of the

following eight months were deficient. May, June, July, and August, which should average 13.36 inches of rainfall, produced only 5.95 inches in 1964. In fact, water was carried continuously in tank carts between June and November. Several severe fires were caused by carelessness and vandalism. The fall planting program was considerably restricted and was completed only in areas easily reached with water. The year 1965, to the date of this report, has been deficient in rain; however, the prevalence of cool weather with temperatures well below normal, has been of some aid in reducing loss of plant materials.

The flowering season of the spring of 1965 was outstanding for crab apples, lilacs, and rhododendrons and much below average for cherries, azaleas, and dogwoods. Records of flowering density and dates of the crab apples have been kept for over a decade; this spring produced the heaviest recorded flowering. As it was also the flowering year for crab apples which are alternate-flowering types the display was superb. A cool dry spell kept the blossoms for a long period, and there appears to be excellent fruit-set. As it was also the best recent flowering season for lilacs, Lilac Sunday was enjoyed by a large number of visitors. In contrast was the poor flowering of most azaleas, the Ghent hybrids being the sole exceptions. In addition, there was a large amount of dead wood in the azaleas which can be attributed to the dry summer of 1964.

The Department of Parks and Recreation of the City of Boston completed the roadway to the top of Peter's Hill during the early summer. This paved turnaround area provides a fine view of Boston as well as a good location for demonstrating the relationship between soil types and forest tree vegetation in the Arboretum and on adjacent properties, and for indicating the area of the land composing the shoulder of the Boston basin.

During the spring months Mr. Seth Kelsey was retained as a landscape consultant in connection with certain problems and problem areas within the Arboretum. In accordance with his suggestions, preliminary work is under way in some areas of the grounds, including a section of wet land across from the Administration Building where a grove of *Metasequoia* has been planted, and an area of shrubbery around Bussey Hill which has been reduced to allow better vision and to develop a better display of ground cover plants.

A preliminary effort has been made in cooperation with the City of Boston to clean and grade a triangular plot of land isolated when Route 1 (Centre Street) was relocated. The excellent varieties of flowering crab apples on the land, which could provide a spectacular approach to Boston from the south, make the additional work and fencing seem justified.

A project suggested for participants in the Job Corps training program proposed for the City of Boston is the reconstruction and repainting of the fence surrounding the Arboretum. In anticipation of this program, old vines growing on the fence were severely pruned during the late winter months.

In the vicinity of the greenhouses, two new beds were established as

Winter work for the ground crew. ABOVE: Composts and manures may be spread effectively at any time of the year. BELOW: Slats for the greenhouse receive protective coats of paint in the attic of the Administration building on a stormy winter day.

a temporary location for genetic dwarf conifers. The plants in these beds have been mulched with a deep layer of crushed rock; a permanent location for them is planned around the *bonsai* house. Additional espalliered

plants have been established along the chain-link fence bordering Centre Street.

The work of the greenhouse staff includes the receipt and distribution of plant materials; the maintenance and service of collections, experimental and research projects; and educational activities.

The records for the receipt and distribution of plant materials as seeds, propagating material, or whole plants indicate the extent of activities. During the year the Arnold Arboretum staff received 288 shipments of plant materials comprising 1482 units from 39 countries. We sent out 294 shipments of 1314 units to cooperating institutions and nurseries in 17 countries. Much of the material received was collected or selected by Dr. Wyman in the course of a trip through Europe which is still in progress. By visiting nurseries, botanical gardens, and research organizations, as well as private gardens, many new plants worthy of introduction and trial in the United States have been located. The acquisition of this material, its shipment and acceptance at ports of entry, and its subsequent quarantine status involve the cooperation and kindness of many individuals and organizations; we are most grateful to each of them. The full amount of material being introduced as a result of Dr. Wyman's trip will be indicated in the annual report of the next fiscal year. Already the number of taxa received suggest that this will prove to be one of the major recent horticultural efforts.

Material has also come in from a sponsored expedition to the Near East and from the efforts of Mr. Hosmer in Afghanistan.

The distribution of materials from the greenhouse facility is partly in response to requests and partly in continuance of a program of distribution and testing. Hardiness testing programs in cooperation with the universities of Minnesota, Maine, New Hampshire, and Vermont and with Iowa State University continue, with the resulting establishment of new ornamental plants in areas previously considered unsatisfactory. In another program, plants are regularly contributed to the North Central Regional Hardiness Testing Program of the United States Department of Agriculture in Ames, Iowa. Plants used for research projects at the Arboretum which need warmer climates for continued growth are grown in one of several gardens in Florida which cooperate with us, or in one of the Gulf states, while new preliminary arrangements now permit limited amounts of material to be grown in one of three locations in Puerto Rico.

Requests for material come from many sources and may be general in nature, or specific to fill particular research needs. It was possible this year to supply material for planting around many new University buildings and to fulfill small requests from some other institutions. In response to many requests material has been supplied to various workers for scientific studies. Fifty-seven kinds of seeds were sent to Iowa State University for use in an investigation of plant proteins which react with certain animal blood-groups. Members of the Araliaceae are still under investigation for their cancer-retarding constituents. An investigation of the accumulation and retention of fluorides in plant tissues led to the request

for leaves of members of the Theaceae. Morphological investigation in many parts of the world led to requests not only for specific plant parts but for specimens collected at definite intervals in the development of the flowers or fruits.

During the year 340 taxa were propagated to serve as replacements on the Arboretum grounds; 107 taxa were processed to provide staff members with material for taxonomic work, teaching, or morphological research. To acquire propagation data for experimental work of the greenhouse staff 76 taxa were processed during the year. Experimental work on the propagation of witches' brooms on conifers continues and shows considerable horticultural promise.

Progress continues on the checking of identification of plants on the grounds and in the preparation of new labels where they are needed. Preparation of specimens from the plants on the grounds not previously represented in the herbarium of cultivated plants has been carried on actively, and additions to the collection of cultivated specimens have also been received from England and Switzerland, together with large collections for identification from Australia, Bermuda, Brazil, Iraq, and Trinidad, as well as the United States. Selected specimens from the greenhouse collections of Cornell University and of Smith College, for which we are grateful, were also made available. An interesting collection of specimens of cultivars of *Erica* and *Calluna* was obtained from the Heather Garden of Mr. H. Copeland, near Chatham, Massachusetts.

Dr. Dudley's introductions of many taxa of *Alyssum* survived the winter in field plantings at the Case Estates and suggest that such taxa from the Mediterranean and the Near East may be of horticultural value in New England. Mr. Green continued his work on *Jasminum* under cultivation. Many of his recent introductions, now released from post-entry quarantine, have been distributed to other gardens for testing. In connection with Mrs. Lily Rudenberg's cytological studies on our Loniceras, Mr. Green checked the identification of much of the collection and made a detailed study of *Lonicera tatarica*, its relatives, and the associated mass of hybrids. A coordinated program of testing *Lonicera* has been planned with the horticulturists of the Moscow Botanic Garden. Seeds of many clones of *Lonicera* have been supplied from localities throughout the Soviet Union; comparable observations and data will be sent from this country.

A registration list for *Weigela* has been completed by Dr. Howard, and lists for *Lantana*, *Philadelphus* and *Sambucus* are in preparation.

Case Estates:

An Open House was held at the Case Estates in Weston on Sunday, May 16th. Several staff members were present to explain the work in progress and to answer questions. The number of individual visitors and organized groups at such events has increased. To explain better the functions of the several plantings and exhibits and to reduce the demands on the staff, a brochure was prepared which, through numbers and arrows,

Special plantings as educational exhibits at the Case Estates of the Arnold Arboretum in Weston, Massachusetts. ABOVE: A demonstration planting of *Lilium* species and cultivars established with the cooperation of the New England Lily Group of the North American Lily Society. BELOW: Perhaps the best known of the plantings on the Case Estates, the ground-cover plant test plots. Periodic reports of the observations made on these plantings are reported in issues of *Arnoldia*.

directs a self-guided tour. The leaflet has proven popular and has much increased both the number and the interest of the visitors. Engraved labels on all of the display plantings helped to distinguish the plantings which are experimental from those of established horticultural value.

Several of the special collections of cultivars have been increased through the generosity of individuals and societies or organizations. The *Hosta* collection now contains the best clones selected by Mrs. Frances R. Williams, of Winchester, Massachusetts. Additional named clones received from the Botanic Garden in Uppsala, Sweden, serve to document the monographic work of Dr. Nils Hylander. Through the kindness of Sir George Taylor, Director of the Royal Botanic Gardens, Kew, selected clones of English origin have been received for trial. Dr. K. J. W. Hensen assisted in supplying the clones of *Hosta* from the collections of the Landbouwhogeschool in Wageningen which documents the registration list of cultivars published in the Netherlands. The combined collections of over 140 clones will permit a cross evaluation of hardiness and horticultural characteristics of plants originating in Europe and in America.

The *Hemerocallis* collection has been increased by additional taxa donated by members of Region 4 of the American Hemerocallis Society. This collection is being developed to show students and the public the characteristics of the species, the variations which are the basis for horticultural classification and selection, and the best of the cultivars.

The *Lilium* collection created exceptional interest locally as it came into flower. Dr. Wyman has maintained records of the flowering periods and related data which were published in an issue of *Arnoldia*. The international requests for this publication indicated the very wide interest in lilies. We acknowledge with appreciation the gift of 400 bulbs of *Lilium superbum rubrum* 'Uchida' sent in furtherance of international friendship and as an example of the breeding and selection work being done in the Kanagawa Prefecture of Japan. The size of this gift has permitted the staff to plant these bulbs in many locations, using different mulches.

On the basis of our observations on the small-tree plot Dr. Wyman has assisted a special committee of the Wire Utility Services of New England to revise their booklet "Trees in your community."

The tree-growth test-plantings of the Cabot Foundation in Weston were re-examined during the year by Dr. Scott Pauley, then cleared of volunteer seedlings and dead trees and subjected to selective pruning. The growth rates of these plantings are compared at regular intervals with plants of the same clones and taxa grown in Jamaica Plain, Petersham, and Quabin, Massachusetts, and in Minnesota.

Herbarium:

Considerable progress was made in curatorial work involving the herbarium quarters, the insertion of mounted materials, and the organization of unidentified collections formerly in storage. The fourth floor of the Administration Building in Jamaica Plain, where part of the herbarium of cultivated plants is housed, was cleaned and repainted. A well-covering

placed between the second and third floors allows better heat control and reduces the noise of activities elsewhere in the building. The collection of unworked and duplicate collections was reorganized for greater efficiency. Work continues on the organization of cultivated plant specimens into the geographical areas where they are grown, on the recognition and marking of type specimens, and on the annotation of specimens representing taxa considered in recently published monographs.

During the year 20,395 specimens were mounted and added to the herbarium collections in Jamaica Plain and Cambridge, bringing the total number of sheets to 806,279. During the year 10,167 specimens were received, the greater portion by exchange.

During the past year staff members and students requested or received for identification 4,317 herbarium sheets representing 95 loans from 36 institutions. The staff filled loan requests for 138 loans to 72 institutions and sent out 14,713 specimens.

Dr. Brizicky completed his studies of the Tiliaceae and Elaeocarpaceae for the Generic Flora of the Southeastern United States and has turned his attention to the Sterculiaceae represented in that area. Studies on the Cistaceae and Vitaceae were the result of earlier studies for the flora project.

Dr. Dudley is continuing studies on the genus *Alyssum*, segregates, and relatives and is preparing a treatment of the group for the *Flora Iranica*.

Dr. Ferguson completed studies of the families Dipsacaceae, Valerianaceae, and Caprifoliaceae in the southeastern United States and has turned his attention to the Cornaceae of the area.

Mr. Green completed work on his collections from New Caledonia, Lord Howe Island and Norfolk Island. Many of these collections were studied at the herbaria of Kew and the British Museum during visits associated with the botanical congress in Edinburgh.

Dr. Hartley began a study of *Zanthoxylum*, including *Fagara* and *Blackburnia*, in the Malesian area. His large collections from Papua and New Guinea have arrived, and the nearly 3700 numbers are being prepared for identification.

Dr. Howard has continued his studies of the plants of the Lesser Antilles, devoting considerable attention to old unidentified collections from the French Islands which have been loaned by the Muséum National d'Histoire Naturelle, Paris. The collections of Dr. and Mrs. Richard Wagner in Puerto Rico include many new records and several new species. Preliminary plans have been prepared for a critical study of the environment, composition, and biology of the mossy forest zone in the Luquillo Mountains.

Dr. Hu made trips to various European herbaria before and after the botanical congress in order to photograph and examine many of the type collections of species of *Ilex*. She has also completed and submitted for publication a bibliography of the Compositae of China.

Dr. Nevling continued his studies of the Thymelaeaceae. He has verified the hybrid origin of *Daphne* × *mantensiana*, as suggested by earlier

studies, and completed a treatment of the Brazilian genus *Funifera*. Studies of *Dirca* and *Schoenobiblus* are in progress. The genera *Decumaria, Pileostegia* and *Schizophragma* are being examined for both their horticultural and botanical interest.

Dr. Perry, although officially retired, has completed the preparation of a manuscript on the medicinal plants of southeastern Asia and has turned her attention again to the Arboretum material collected in New Guinea by Dr. Brass and others.

Dr. Schubert had the opportunity of examining type specimens and other important historical collections of the genera *Desmodium*, *Dioscorea*, and *Begonia* during visits to herbaria at Edinburgh, Kew, and the British Museum.

Dr. Wood has continued his direction of the work toward completion of a Generic Flora of the Southeastern United States. The extensive list of family treatments already prepared is scarcely indicative of the important background work also accomplished in the preparation of bibliographies, lists of abbreviations, glossaries, and the supervision of the preparation of the illustrations. Dr. Wood also studied types and critical material of the genus *Hedyosmum* at British and European herbaria before the botanical congress.

We are pleased to have had many visitors who examined material in their special groups for varying periods of time. These studies involved not only the herbarium and library, but also the special collections of fruit, wood, pollen, and the living collections in Jamaica Plain and Weston. Among others, Dr. Quentin Zielinski, of Oregon State University, used almost all the facilities for his work on the genus *Pyrus*; Dr. Howard Scott Gentry, of the U.S. Department of Agriculture, started an examination of our material of *Agave* and studied the pertinent literature, as well as the special collections and notes prepared by Mrs. McKelvey. Dr. R. J. Williams, of the CSIRO of Australia, consulted with Dr. Schubert regarding *Desmodium* and other Leguminosae and checked specimens and distributions in the herbarium before continuing his trip for field work in South America. Dr. Stauffer, completing a trip around the world devoted to the study and collection of material of the Santalaceae, spent a month studying and annotating our material. Dr. Philip Munz used the herbarium for an extended period in connection with his work for the new edition of *Hortus* being prepared at the Bailey Hortorium of Cornell University. Mr. Dieter Wasshausen, of the United States National Herbarium, was one of the visitors especially interested in the methods and procedures used in the herbarium.

The herbarium and library are the depository for many valuable special collections. We are happy to acknowledge a particularly interesting gift this year of the manuscripts, specimens and fragments, and photographs compiled by the late Dr. Henning Horn af Rantzien in his studies of *Potamogeton* and other aquatic flowering plants. This material, the gift of his widow, Mrs. Anna Horn af Rantzien, will be available for the study of visiting scholars.

Library:

Much of the activity of the library staff during the year concerned the organization and evaluation of material received as bequests and gifts, and of older collections needing additional work. Mrs. McKelvey, who knew our library as well as any individual could, enriched it still further by leaving 280 of her books to be added to our collection. Her earlier gifts of supporting materials to her work on lilacs, yucca, and the Trans-Mississippi West have been acknowledged in previous reports.

Mr. Seth Kelsey, a friend of the Arboretum and a member of the Committee to Visit the Arnold Arboretum for many years, moved from the Boston area and was forced to dispose of the records of his father, the late Harlan P. Kelsey. Since much of the material concerns the development of horticulture in New England, the staff of the Arboretum has accepted this collection for study and organization prior to appropriate disposition of parts of the material on national parks, city planning, standardized plant names, the American Horticultural Society, and the Arnold Arboretum. Of particular value and interest to the Arboretum will be the extensive correspondence of Mr. Kelsey with Charles Sargent, E. H. Wilson, and many other members of the staff.

We are grateful to Mr. H. H. Richardson, to Mr. Malcolm A. Milne, and to others who do not wish to be named for large collections of books.

Many books and pamphlets on plant morphology and plant anatomy which were transferred in 1933 to the library of the Biological Laboratories have been reincorporated in the library collections of the Arnold Arboretum.

Considerable effort has been devoted to reorganizing the reprint collection of the late Professor J. H. Faull. The system of classification which was useful to the compiler has not proven to be a practical one for a modern library, making a reorganization essential. Many of the reprints concerned with forest plant pathology, accumulated while Professor Faull was on the staff of the University of Toronto were offered to the Shade Tree Research Laboratory of the University of Toronto and were gratefully accepted.

Miss Stephanne Sutton has undertaken the task of organizing the material and correspondence concerning the history of the Arnold Arboretum. We are requesting from other institutions "xerox" or other copies of letters of historical interest to and from Arboretum staff members. Mr. Henry de la Montagne, of the New York Botanical Garden, has been instrumental in supplying copies of correspondence from that institution, and his assistance is deeply appreciated.

During the year 647 bound volumes were added to the library of the Arnold Arboretum bringing the total to 52,864. Two hundred and forty volumes concerning horticulture were deposited in the library in Jamaica Plain. We acknowledge the assistance of Mr. Theodor Mayer, of Montreal, Canada, for his interest and help in adding to the Arboretum holdings of volumes on the genus *Rosa*. Reprints and pamphlets totalling 450 were added to files of monographs and author separates making a total of

20,274 items so catalogued. Many of the older reprints were placed in permanent covers with typed indices.

The annual published increment of 3000 cards was added to the *Card Index of American Plants* issued by the Gray Herbarium. Sixteen hundred title cards were added to the *Index to American Botanical Literature* published by the Torrey Botanical Club. Number 20 of the *Index Nominum Genericorum* series was received and incorporated. Over 1400 index cards appropriate to the Rehder index of cultivated plants were prepared and inserted in the series.

Mrs. Schwarten has continued her work on the preparation of standardized abbreviations for bibliographic citation. She is working with Mr. Green and Dr. Howard in the compilation of literature citations used in the registration lists of cultivar names being published. To this index will be added citations for nurseries and nursery catalogues which have proven to be sources of cultivar names. Publication is expected in this calendar year.

Comparative Morphology:

Professor Bailey is continuing his investigations on the primitive leaf-bearing Cactaceae under an extension of his grant from the National Science Foundation. At present he is concerned with the occurrence of "protein bodies" in *Pereskia* and *Pereskiopsis* and with the formation of water-soluble anisotropic bodies in dehydrated leaves of these genera. Papers numbered XII and XIII of the series dealing with these significant groups have been published during the year.

Professor van der Schijff, since the first of the year, has been working in this laboratory. He has undertaken an investigation of the unusual growth characteristics and subterranean stem development in many of the Leguminosae from arid regions of South Africa. Seeds of *Elephantorrhiza elephantina*, *Erythrina burkei*, *Erythrina humeana*, and *Erythrina zeyheri* were started in the greenhouses of the Arboretum and showed the same characteristics of shoot dormancy exhibited by these plants in the Southern Hemisphere. In its native habitat *Elephantorrhiza elephantina* may be regarded as a noxious weed because of the persistence of its enlarged subsurface base. A study of the seedling development of all four species will yield information about the origin of the characteristic elephantine stem forms of these plants.

Dr. Howard has continued his studies of nodal and petiolar anatomy with attention devoted to securing information concerning families of plants not well represented in the available flora, or families of recent description, and genera regarded as having questionable affinities.

Cytology and Genetics:

Dr. Sanders has continued her studies of the cytology of various colchicine treated lines of *Sorghum*. The investigation involves diploid mutants obtained from both diploid and tetraploid seedlings. Chromosome counts have been made for most of two hundred untreated and

Arboretum classes indoors and out-of-doors. ABOVE: Members of the plant propagation class conducted by Mr. Fordham take over the work areas of the Dana Greenhouses at the Thursday evening and Saturday morning classes. BELOW: Maples in flower may not be spectacular, but Dr. Nevling takes time to explain the taxonomic and horticultural characteristics of the plants in an Arboretum class.

treated plants. Some diploid mutants showed cytological disturbances at diakinesis associated with a premature fractionation of the nucleolus. These will be studied for possible evidence of chromosome changes in the mutants.

The development of information on the technique of germinating seeds of woody ornamental plants has produced many seedlings which are considered expendable in a variety of additional experiments. Colchicine has been applied to a number of these to observe the nature and frequency of changes induced and to determine the possible horticultural value of plants so influenced. Seedlings of 12 species were treated with 0.5 per cent colchicine in lanolin and kept for seven days under 250 watts of infrared light at temperatures of 60 to 80 degrees F. and in high humidity. An equal number of seedlings without colchicine treatment were raised in the same environment as control plants. Following the infrared light treatment all plants were raised in normal greenhouse environment. Nearly every lot of untreated seedlings showed some reaction to the infrared light, most often the plants died. The loss was particularly severe in the seedlings of *Cornus kousa*, *Magnolia obovata* and *Tsuga caroliniana* suggesting further work on infrared effects on germination and seedling development is essential. The colchicine treated seedlings showed phenotypic variation from stunted growth habits to plants of exceptional vigor. Polyploidy is suspected in five of the 12 species tested. Verification will come when the plants are larger and chromosome counts can be checked.

Chromosome counts are made routinely on much of the material processed in the greenhouses or grown on the grounds. Counts are recorded on voucher herbarium sheets as well as on the record cards of the taxa. During the year Dr. Sanders obtained a preliminary chromosome count from root tips of seedling *Austrobaileya*, the first record known to us for that genus. Chromosome counts were also made in association with research projects on species of *Prinsepia* and on the dwarf seedlings developed from witches' brooms of *Pinus strobus*.

The existence of a triploid plant of *Forsythia* has been questioned recently in literature from Europe. A re-examination of all plants labelled *Forsythia* 'Beatrix Farrand' in our collection, as well as additional material received from nurseries under that name, has revealed all plants to be tetraploid. Since the original chromosome count was made and verified by competent cytologists it is possible either that only a single shoot showed this abnormality or that the triploid plant has been lost. Any suggestions of sources of the original plants distributed as triploid *Forsythia* 'Beatrix Farrand' will be welcomed.

Mrs. Rudenberg has continued her cytological studies of taxa of *Lonicera* in a systematic examination of plants in the living collections of the Arboretum. To the present, chromosome counts from 72 plants in 30 different species have been obtained. The species of *Lonicera* appear to be predominantly diploid, $2n = 18$. There are relatively few polyploids in the genus, yet some species have indistinguishable diploid and tetraploid forms. Many taxa have been counted for the first time and tetraploid

forms have been found in varieties of species previously considered diploid.

Dr. Nevling has obtained chromosome counts from several species of tropical plants important to work in progress in Puerto Rico.

Education:

Two formal courses in Harvard College were offered by members of the Arboretum staff during the year. Dr. Howard taught a new course, Biology 209, The Phylogeny of the Flowering Plants. During the mid-semester vacation the class travelled to a field location in Puerto Rico and, with the assistance of Dr. Wood, spent a week in closer examination of many families limited to the tropics. In the spring semester Dr. Wood and Mr. Green taught Biology 103, an introductory course, The Taxonomy of Vascular Plants. A special financial arrangement was made with the Department of Biology permitting this cooperative effort.

Graduate students, undergraduates, special students and Mercer Fellows worked with several staff members for guidance and in the development of special problems in taxonomy or in horticulture. Most of the staff attended and participated in the seminar series on plant taxonomy held in the Harvard University Herbarium building.

The informal classes offered without academic credit to the general public were conducted in Jamaica Plain and in Weston. The fall field class, with emphasis on horticultural practices, was conducted by Dr. Wyman in Jamaica Plain. Dr. Sanders led the class in Weston, considering some of the cytogenetical problems of plant populations in the wild and under cultivation. Mr. Fordham again taught a class in plant propagation which met at appropriate intervals for the work to be done throughout the year. In the spring, the Weston field class was held on Tuesday and Thursday evenings between 6 and 7 P.M. interesting a different group of people than had come for the afternoon classes. Dr. Howard, with the special assistance of Dr. Hartley and Mr. Williams, was responsible for the classes. In Dr. Wyman's absence, the spring field class in Jamaica Plain was led by members of the staff and it, too, was held at a different time, Saturday morning. The new audiences coming to the classes held at different times suggests that varying the days of the classes every few years may make them of greater value to a larger number of people.

Several special programs were arranged to meet specific requests. Mr. Fordham conducted a workshop on the germination of woody plant seeds in the Dana greenhouses for guests of the Massachusetts Horticultural Society. Dr. Dudley participated as a guest instructor in a course offered and sponsored by the Massachusetts Department of Education at the State College in Boston. The course, entitled "Environment for Living," considered open spaces and recreational areas. Two laboratory sessions for the students were arranged at the Arnold Arboretum. The group hopes to conduct a survey of the street and park trees of greater Boston as a basis for recommendations for city beautification programs.

The facilities of the Arboretum came into use for many visiting groups of horticulturists and nurserymen, as well as for classes from New England

colleges. Again this year, the judging and identification contest of the University of Massachusetts, the Massachusetts Department of Agriculture, and the Boston Public Schools was held in the Administration Building. The staff also made arrangements for the mid-winter meetings of the Northeastern Section of the American Society of Horticultural Sciences which were held in the Biological Laboratories.

The participants in the discussions of botanical nomenclature preceding the X International Botanical Congress in Edinburgh, Scotland. The meetings were held in the botanical lecture hall adjacent to the new herbarium and library building shown in the photograph. Jalmar photograph.

The staff was represented at sessions of the Nomenclature Section and the remainder of the X International Botanical Congress at Edinburgh by Drs. Howard, Hu, Nevling, Schubert, and Wood, and Mr. Green. Dr. Sanders attended the AIBS meetings in Colorado. Drs. Howard and Wyman attended the meetings of the AABGA at Planting Fields Arboretum which were held in association with the American Horticultural Congress. The American Horticultural Society, in cooperation with Colonial Williamsburg, sponsored the annual Williamsburg Garden Symposium this spring. Dr. Wyman presented a program on low maintenance gardening and the plants which make it possible. Mr. Fordham attended the International Plant Propagators' Society meeting at Rochester, New York. He spoke there and at the regional meeting of the Federated Garden Clubs at the Waltham Field Station.

During Dr. Wyman's trip to Europe this spring he has been asked to speak and often to describe the activities, facilities, and resources of the Arnold Arboretum. These meetings included those of the International

Dendrological Union, the Scottish Garden Society, and the International Camellia Society.

Exhibits and Displays:

For the first time in a number of years the Arboretum did not participate in the Spring Flower Show of the Massachusetts Horticultural Society. Impending changes in the physical plant necessitated commitment of labor and the requirements of greenhouse space for research materials and experiments in progress did not permit the forcing of trees and shrubs in time for the Spring Show. A demonstration of mulching materials similar to that shown at the Massachusetts Spring Flower Show last year was exhibited for the 19th American Horticultural Congress held in the Commodore Hotel in New York in September.

Opening Plenary Session of the X International Botanical Congress held in Usher Hall, Edinburgh, Scotland, August, 1964. Jalmar photograph.

Open houses were held in Weston and in Jamaica Plain during the spring. The Massachusetts Horticultural Society, in awarding a gold medal to the Arnold Arboretum, requested our participation in a program of open gardens of award winners. For this two-day activity the staff prepared special exhibition cases, including new kodachrome transparency displays and demonstrations relating to plant exploration, the preparation of herbarium specimens, and techniques of plant identification.

Mr. Heman Howard prepared a special set of display photographs of the Larz Anderson collection of *bonsai* of the Arnold Arboretum. The set of photographs, showing individual specimens, as well as the methods of housing and displaying the *bonsai*, is available on loan. During the year these photographs were displayed for a special exhibit of the Garden Club of America in the Goldsmith Civic Garden Center in Memphis, Tennessee.

Dr. Hu prepared and exhibited a colorful demonstration concerned with

the lines of evolution in the genus *Ilex*, the hollies, at the X International Botanical Congress at Edinburgh.

Travel and Exploration:

The X International Botanical Congress in Scotland afforded staff members attending the opportunity of taking part in tours to various botanical gardens and of visiting herbaria and botanical institutions. Mr. Green worked at the herbaria of Kew and the British Museum (Natural History) both before and after the Congress. Dr. Howard travelled to Denmark, Germany, France, and Belgium following the Congress, visiting gardens and herbaria in each country before returning to the institutions in London en route home. Dr. Hu received a special grant from the research funds of Sigma Xi which permitted her to study material of *Ilex* in herbaria in London and Edinburgh, as well as Munich, Vienna, Berlin, Göttingen, Leiden, and Brussels. Dr. Nevling received a travel grant from the National Science Foundation through an award committee of the American Institute of Biological Sciences which enabled him to observe curatorial procedures at the major herbaria in England and Scotland, the Netherlands, and France. Dr. Schubert worked in the herbaria in London, and in Edinburgh during the Congress. Dr. Wood made an extensive trip through Europe before the Congress visiting gardens in Italy, Germany, Austria, France, and Switzerland and making photographs of plants to be used in his course in plant taxonomy. He examined material in the herbaria in

Field work in the Luquillo Mountains in eastern Puerto Rico. Sir George Taylor, Director, Royal Botanic Gardens, Kew; Dr. Richard Howard; and Mr. Roy Woodbury, of the University of Puerto Rico. October, 1964. From a Kodachrome by Anstiss B. Wagner.

London, Paris, Geneva, and Copenhagen, and solved many problems which had arisen from his studies of the flora of the southeastern United States.

Drs. Howard, Nevling, and Wood made trips to Puerto Rico in programs of teaching and research. Materials for anatomical and cytological studies were collected as well as specimens for special illustrations. Dr. Howard attended a meeting of the Council of the Association for Tropical Biology in Caracas, Venezuela. With the cooperation of botanists of the Instituto Botánico materials for petiolar studies were collected in the Parque Henri Pittier and in the Botanical Garden.

Mr. Hosmer was able to collect material of plants worthy of trial in the Boston area in several locations in Afghanistan.

During the spring and early summer of 1965 Dr. Wyman is spending several months in Europe to obtain plants thought to be new to the United States and to be hardy out-of-doors at the Arnold Arboretum. These plants have been sought from the native floras, as well as in introduced and cultivated collections in botanic gardens, arboreta, private gardens, and nurseries.

The Arboretum has agreed to share the expenses of several expeditions or to purchase herbarium collections or seeds from botanists of other institutions. During the year support was afforded expeditions in Turkey, Guatemala, Puerto Rico, South Africa, and Western Australia.

Gifts and Grants:

During the fiscal year 1963–64, property belonging to the Bussey Institution was taken by the Commonwealth of Massachusetts by right of eminent domain. On this property were the old buildings forming the greenhouse complex of the Arnold Arboretum. The value of the buildings alone was credited to the Arboretum shortly before June 30, 1964, when the sum of $14,806.69 was added to the principle of the Bussey Fund for the Arnold Arboretum (1903), for that portion of the net proceeds of the Bussey Institution land settlement. This transaction was not recorded in sufficient time to be included in the Director's Report of the appropriate fiscal year.

The Friends of the Arnold Arboretum renewed their gifts during the year, and these funds were assigned as usual to an account for work on the grounds in Jamaica Plain or for activities in the horticultural department and the greenhouses. We are grateful for the generous and loyal financial support of the Friends for the work of the staff. A record of the gifts is published quarterly in the "Gifts to Harvard," and the complete fiscal review is published annually in the Financial Report to the Board of Overseers of Harvard College.

Gifts of materials for the horticultural collections, the library, the herbarium, or special research purposes were many and have, in general, been noted in the appropriate section of this report. Special gifts included a collection of orchid plants from Mr. and Mrs. Robert Preston for research projects and for teaching; a number of plants or propagation materials

from the hollies of the late Wilfred Wheeler made possible through the Massachusetts Audubon Society; a large gift of special lily bulbs from the Ofuna Botanical Garden in Kanagawa-Ken, Japan; a very old and large *Taxus baccata* 'Adpressa' from Mr. Harry W. Fowle; a large number of books from the estate of Mrs. Susan McKelvey; many kinds of records

An old specimen of *Taxus baccata* 'Adpressa' prepared for transplanting to a location near the Dana Greenhouses in Jamaica Plain. This plant was the gift of Mr. Harry W. Fowle, shown in the photograph by Heman Howard.

and files from Mr. Seth Kelsey. We are grateful for these and smaller gifts of similar nature.

Publications:

Four numbers of the *Journal of the Arnold Arboretum* were issued during the fiscal year under the editorial direction of Dr. Schubert. The numbers contained 462 pages and 21 articles, primarily by members of the staff. We welcome the first half of the series of letters from Charles Sprague Sargent to the Louisiana botanist, Reginald Somers Cocks, which have been edited by Professor Joseph Ewan of Tulane University. Publication of the remainder of the series of letters will be in the current volume of the *Journal*. The full series will be available as a single bound reprint.

Two large manuscripts were completed during the year and submitted for publication as independent studies. A cumulative index to the nine volumes comprising Urban's *Symbolae Antillanae* was prepared by Miss Sutton and Miss Carroll. It will be published in August by the Arboretum. An encyclopedic bibliography of the medicinal and poisonous plants of

southeastern Asia was completed by Dr. Perry and is being considered by a private publisher.

Since volumes 1–10 of the *Journal of the Arnold Arboretum* have long been out of print and the supply of many single numbers has been exhausted, the available back numbers were sold during the year to the Kraus Reprint Corporation, 16 East 46th Street, New York, N.Y. 10017, under a contract to reprint the first twenty volumes and all out-of-print numbers, and to offer all for sale.

The bibliography which follows lists 76 articles and books by members of the staff which were published during the past fiscal year.

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